



THE PLAGUES OF EGYPT

There's real evidence behind the legend

BIG DATA

Why information is power



ROCKET CAR

How science will smash the land-speed record



AUSTRALIAN

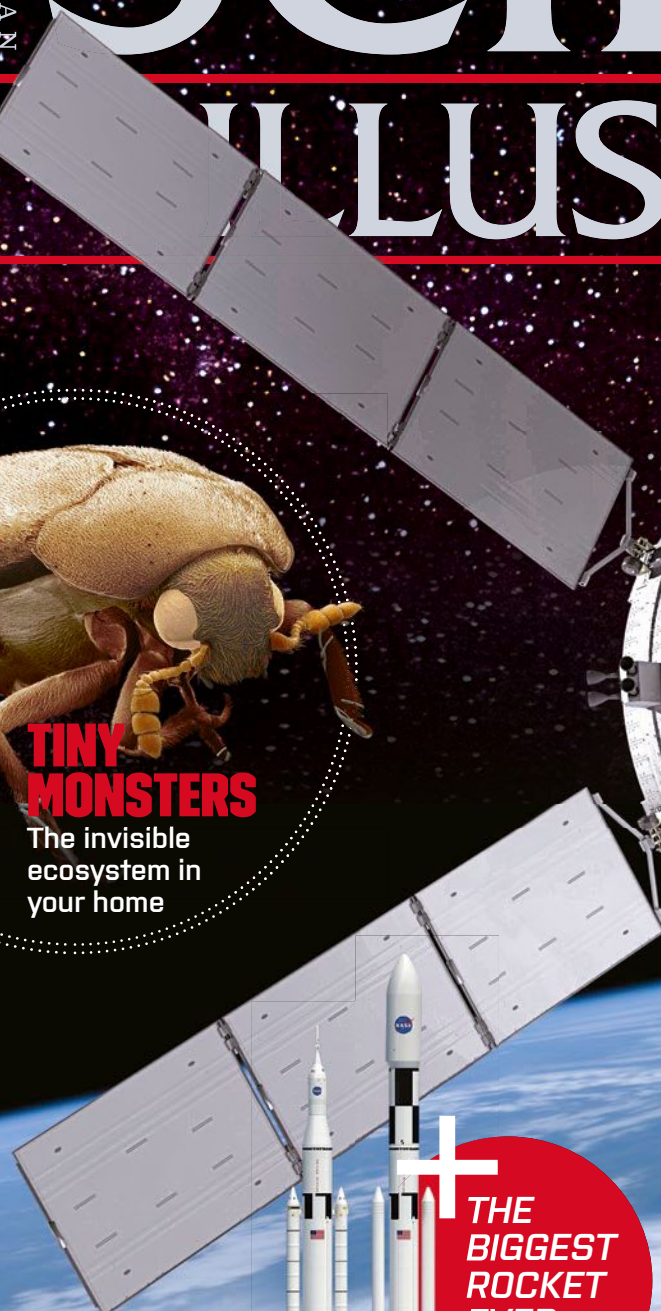
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THE SCIENCE ILLUSTRATED CREDO

We share with our readers a fascination
with science, technology, nature, culture
and archaeology, and believe that through
education about our past, present and future,
we can make the world a better place.

Welcome to the Future



A little over nine months from the on-sale date of this issue of Science Illustrated is an important anniversary. Because 21st October 2015 is the day Marty McFly arrived (arrives?) in "the future", departing 1985 via DeLorean time machine.

This little factoid is a favourite among sci-fi geeks because *Back to the Future II* (actually released in 1989) is such an iconic Hollywood time-travel tale. But it's an imposing thought. Fifteen years into the new millennium and we really can't avoid it anymore: we live in the future. The actual future, as depicted by movies, books, comics and more. In fact for the longest time, the Year 2000 was the future. Often a post apocalyptic future. Yet here we are.

Part of it is simple psychology. Our high-tech civilisation came of age when the year had a one in front of it. 1700s, 1800s, 1900s - sure it's three centuries but at some point we agreed, at least in the West, that "the future" wouldn't really begin until the 19 clicked over to 20.

It's amusing to rewatch *Back to the Future II* to see which parts of "the future" 1989 scriptwriters got right... and wrong. Flying cars? Not so much. Shoes that self-tighten? Well, Nike DID make the shoes, but only as a tribute to the movie. Nostalgia for 1980s videogames? Bang on. Home automation? Yes - and in exactly the same kind of "McMansion" the future McFlies live in. Giant televisions that take up a whole wall? Yep. Which split into dozens of smaller windows showing multiple channels? Er, well depends on your model but some TVs do that a bit. And they're voice-controlled too.

For me one of the neatest predictions is the full-colour newspapers. Back in 1989, most papers still ran in black and white. Yet as we know, papers went full colour in the 90s... and now of course they are being superseded by smartphones and tablets.

This is where the fictional futurists of Hill Valley, circa 2015, really missed out. Like so many other soft sci-fi writers, they totally failed to spot the rise of small, powerful personal computing devices. There were plenty of cellphones and carphones in 1989 - but they were associated with Wall St types. Seems no one thought it plausible that teenagers would have their own by 2015.

And of course there's the internet and notebook computers. This omission shows the filmmakers probably didn't consult that widely when building their future suburb. There were lots of PCs in 1989, and plenty of enthusiasts were networking them over phone lines. It seems weird now, watching the film, to see a home - full of voice-activated lights and fruit-dispensing ceiling-mounted whatchamacallits, and instant-rehydrated pizza - without, as far as I can tell, a single computer in it. Failed-future Marty McFly even gets fired by FAX.

Of course, the film is a comedy. Half of the future stuff in it is designed to make fun of 1989's obsession with fax machines and traffic jams and Jaws sequels.

Oh yes - and it looks like we'll be getting a hoverboard soon too (www.hendohover.com). The only question is: will it make it to market by 21st October? Marty will be waiting.

Anthony Fordham

Twitter: @sci_illustrated

Facebook: facebook.com/ScienceIllustratedAus

THINGS WE LEARNED IN THIS ISSUE

- + The **ROYAL NATIONAL PARK** is incredibly close to Sydney, but still incredibly wild.
- + NASA's new **ORION CAPSULE** is like an upgraded version of Apollo. So we know the concept works!
- + When you drive a **ROCKET CAR** at 1,600 km/h you need four kinds of brakes to stop.
- + Our homes are full of **TINY MONSTERS** and they love to eat us and all our stuff!



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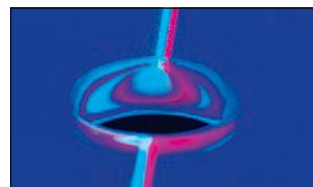
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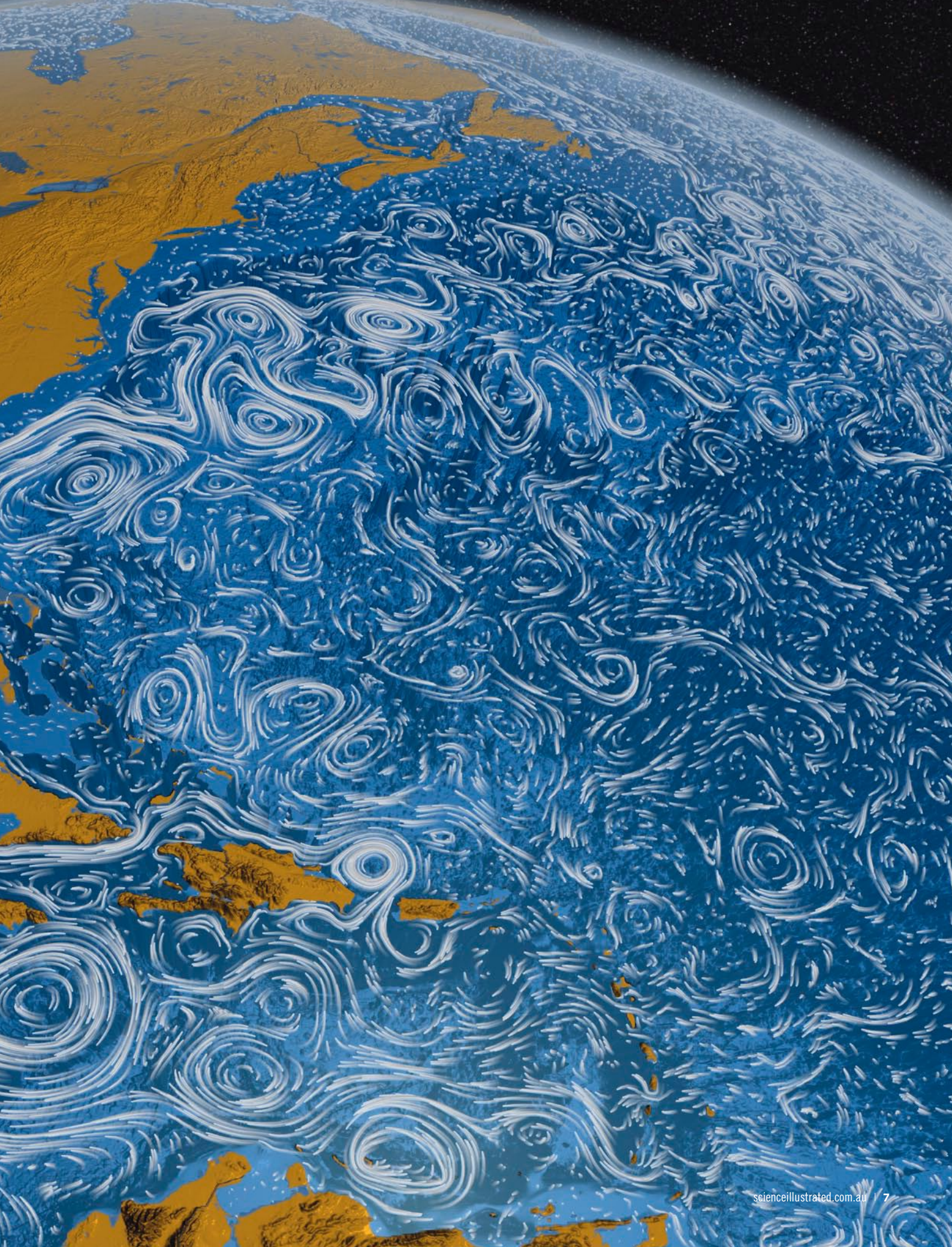
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↓ SATELLITES REVEAL ALL OCEAN CURRENTS

Over the last 2.5 years, NASA has monitored ocean currents via satellites featuring resolutions that make even the tiniest eddies stand out. The result is an overall picture of the surface currents of all the oceans of the world. Ocean water carries heat and carbon, and mapping water currents shows how water moves around the Earth, affecting the climate. The different blue shades of the ocean in the picture indicate the water depths beneath the surface currents.

GSFC/NASA



MEGAPIXEL



Worldmags.net





↓ HUNGRY SPIDER USES ITS FANGS TO CATCH FISH

A raft spider is lying in wait on a rock in the lake. A small fish swims close by, and in a flash, the hungry predator has grabbed the unsuspecting prey with its fangs and dragged its wriggling body out of the water. Scientists have long known that some spiders can fish, but now, new scientific research demonstrates that the behaviour is actually common and widespread throughout the world. Over 330 predatory spider species and five other families of water-loving arachnids regularly go fishing. The fish are around 2-6 cm long and typically smaller than the spider itself.

DOLOMIDES FIMBRIATUS

Editors: Karen Grubbe

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lactic acid bacteria with unique antibacterial qualities have been identified by scientists in bee stomachs.

FOUR PROBES MAPPED OUT MARS

↓ Scientists use 16 years of observations to make a detailed map of the planet.

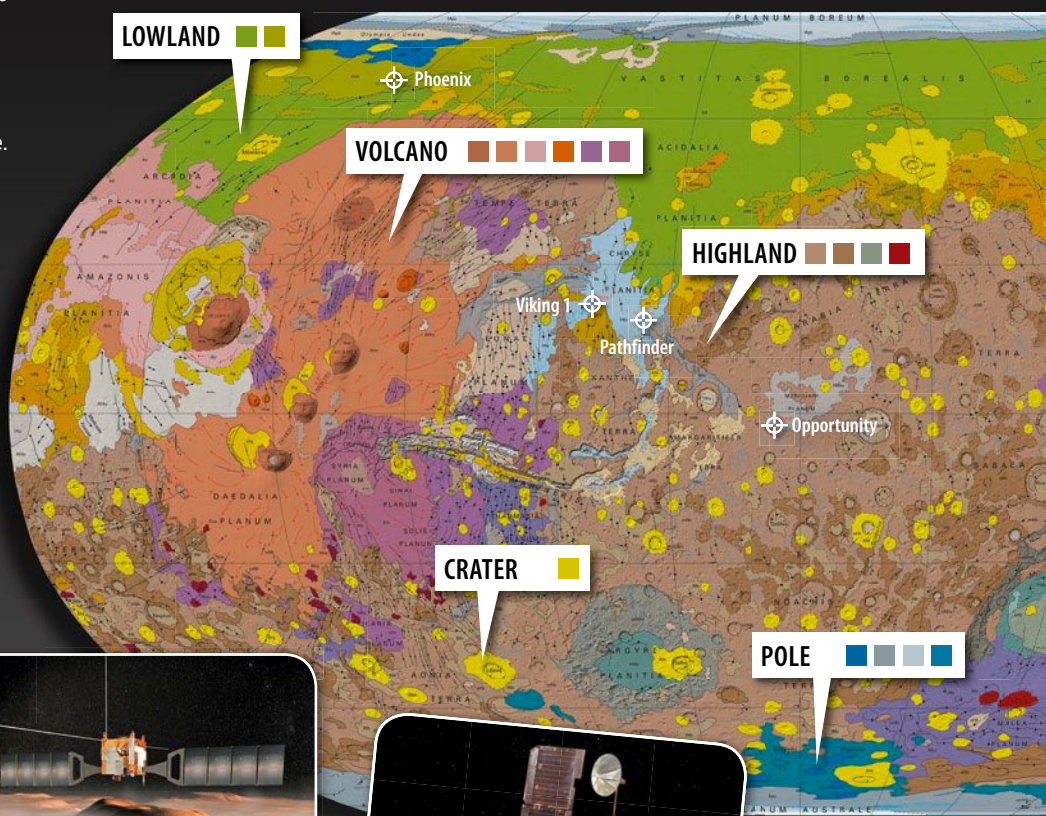
AEROSPACE Thanks to more than 16 years of work done by four Mars probes, scientists now have access to the most detailed map of the surface of Mars ever made. The map not only indicates the best landing sites for future expeditions to the Red Planet, it also provides us with new knowledge about the planet's geological history: Major parts of the surface are much older than scientists used to believe.

Pieced together by the American National Institute of Geological Sciences, the map is based on observations and measurements from four probes: Mars Global Surveyor, Mars Odyssey, Mars Express, and Mars Reconnaissance Orbiter. The first data were supplied by Mars Global Surveyor, which reached Mars orbit in September 1997, followed by information from the other three probes.

The map gives us a new

understanding of the geological processes that shaped the surface. Moreover, the mapping confirms assumptions that Mars has been geologically active until the

present and reveals that major parts of the surface were formed in the first great geological period that lasted from Mars' birth until some 3.8 billion years ago.



Mars Global Surveyor

The probe orbited Mars for nine years, from September 1997 to November 2006. It produced an altitude map by shooting laser beams at the surface, and it measured Mars' magnetic field.

LAUNCHED BY: NASA

TIME IN ORBIT: 9 years and 1 month

Mars Express

The first European probe. Since December 2003, it has taken 3D photos and made different measurements concerning Martian chemistry and geology, using technology such as radar.

LAUNCHED BY: ESA

TIME IN ORBIT: 10 years and 8 months

Mars Odyssey

Mars Odyssey reached Mars in October 2001 and is the oldest probe still orbiting the planet. The probe has taken snapshots of the surface by means of an infrared camera.

LAUNCHED BY: NASA/JPL

TIME IN ORBIT: 12 years and 10 months

USGS

Scientists have found the remains of a dinosaur, which lived 70 million years ago. Its skull measured 63.5 cm.

MAP INDICATES LANDING SITES

The four probes have made an extremely detailed map of Mars, which will be the starting point of future exploration of the planet and guide scientists to appropriate landing sites.

Rover landing sites

LOWLAND

Viking 2

Curiosity

Spirit

VALLEY



Mars Reconnaissance Orbiter

The probe has been orbiting Mars since March 2006 and is equipped with the best camera ever brought to another planet. The camera photographs objects as small as one metre across.

LAUNCHED BY: NASA/JPL

TIME IN ORBIT: 8 years and 6 months

SCIENTISTS GROW 3D BRAIN TISSUE

Based on a sponge made of six layers of coloured silk, American scientists have grown artificial brain tissue in 3D. The brain cells come from rats and grow in all directions like in a real brain. Scientists intend to injure the artificial brain by for instance a concussion and subsequently measure the activity.

TUFTS UNIVERSITY



PREHISTORIC PENGUIN WAS THE TALLEST EVER

PALAEONTOLOGY In Antarctica, scientists have found the fossils of a long-extinct giant penguin, which was taller than all other extinct and modern penguins. The 1.6-m-tall and 115-kg-heavy penguin waddled the Earth 37-40 million years ago, and compared to this giant, modern emperor penguins of 1.2 m are dwarfs.

The extinct species has been named *Palaeodyptes klekowskii*. It was discovered by scientist Carolina Acosta Hospitaleche, who estimates that due to its size, the penguin was able to remain under water for 40 minutes at a time.



PALAEODYPTES KLEKOWSKII
1.6 metres

GIANT PENGUIN WAS 1.6 M TALL

Weighing as much as 115 kg and with a height of 1.6 m, the extinct penguin species was definitely a giant.

EMPEROR PENGUIN 1.2 metres

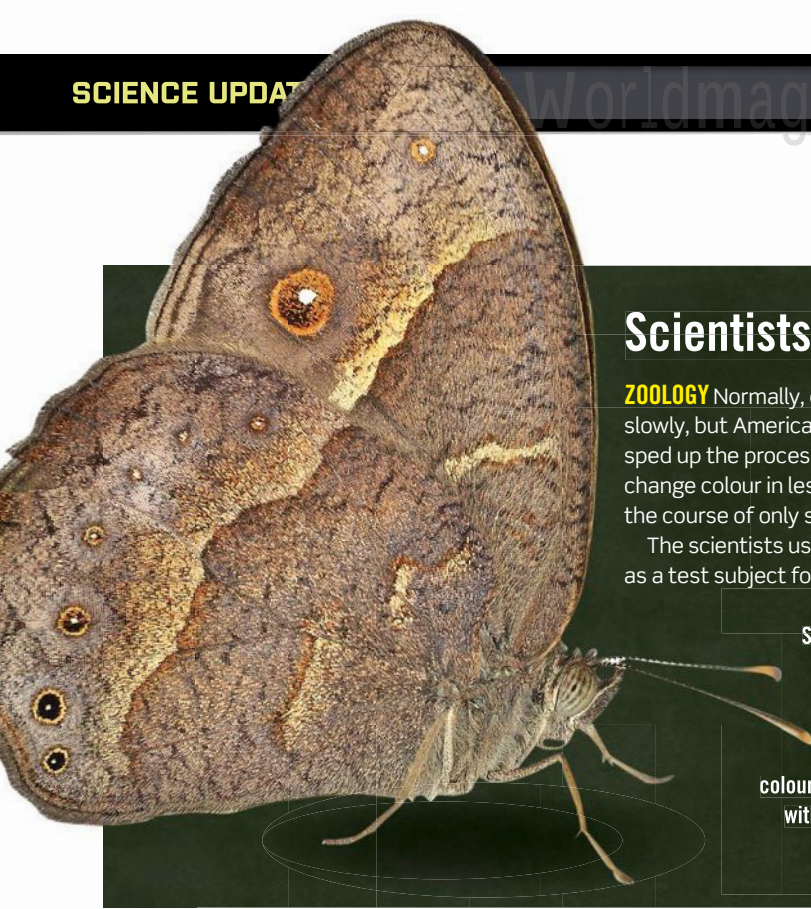


MODERN PENGUINS

EXTINCT PENGUINS

C.A. HOSPITALECHE/MUSEO DE LA PLATA

Magic mushrooms could treat depression, as even small quantities of the psilocybin compound weaken the brain's processing of negative emotions.



Scientists apply new colour to butterflies

ZOOLOGY Normally, evolution works very slowly, but American scientists have sped up the process, making butterflies change colour in less than a year and in the course of only six generations.

The scientists used a brown butterfly as a test subject for the artificial

evolution. In the lab, the scientists hand-picked the individuals whose wings reflected the light of the violet wavelength the best, and made the selected individuals reproduce. The procedure was repeated, and after only 6 generations, the butterfly was bluish.

Scientists have managed to make an animal change colour by tampering with evolutionary principles.

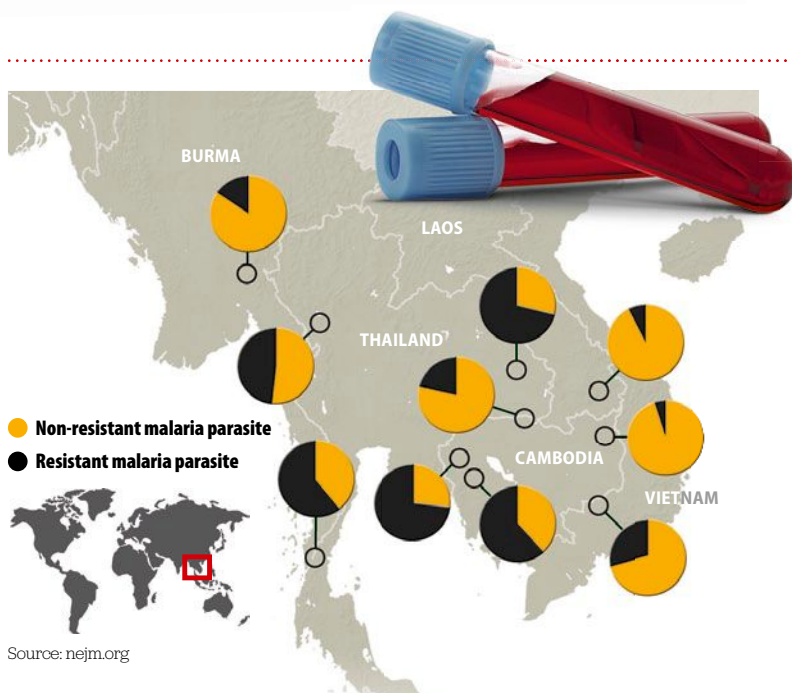
NATURAL COLOUR



AFTER 1 YEAR



YALE UNIVERSITY & GILES SAN MARTIN



BLOOD SAMPLE REVEALS SPREAD OF RESISTANT MALARIA PARASITE

One of the world's biggest killers, the malaria parasite, is becoming even more lethal.

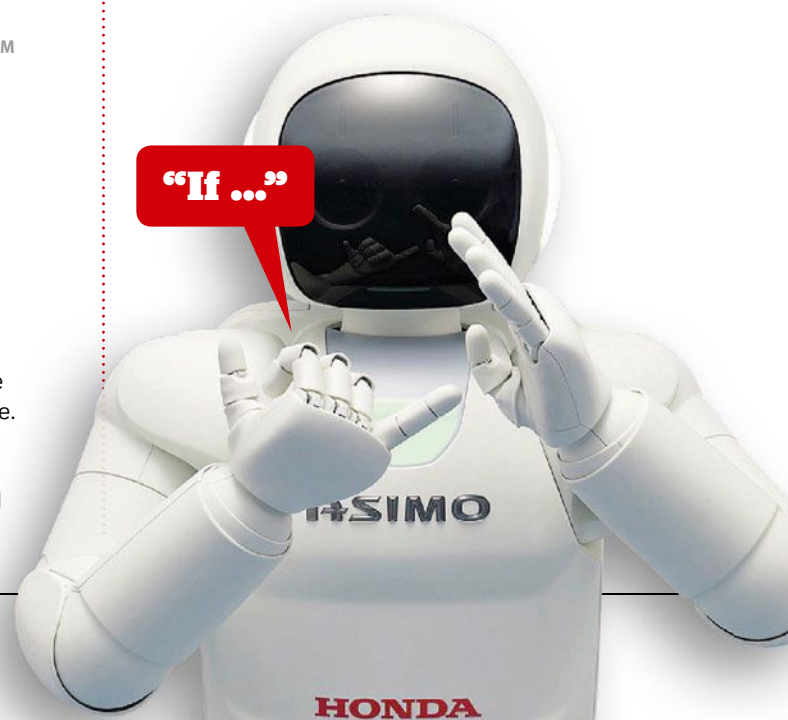
In major parts of Asia, the parasite has developed resistance against the only efficient drug,

artemisinin. The resistance is due to a mutation of the kelch13 gene. Via blood samples from patients, doctors can now observe the spread of resistant parasites and monitor the situation.

HUMAN-LIKE ROBOT USES SIGN LANGUAGE

Over the past 14 years, Honda's Asimo robot has developed from a simple humanoid machine into an autonomous miracle. In the most recent version, the sensitivity of Asimo's hands has been improved, allowing the robot complex motion such as removing lids and communicating in sign language.

HONDA



HONDA

▶ 99.965

% of all visible light is absorbed by the recently developed Vantablack material: the blackest substance in the world.

STRANGE – BUT TRUE!



▶ Sea plankton found on the ISS

Russian scientists have found small sea plankton and other microscopic organisms living on the outside of the International Space Station (ISS). The scientists do not know how the tiny passengers found their way to the space station.

▶ Press-button pleasure

An American inventor has patented an implant that triggers an orgasm when you press a button. The implant stimulates the nerves and is aimed at women who cannot achieve natural orgasm.

▶ Friends share DNA

Apart from taste in music, you may also share DNA with your friends. In a new study, American scientists analysed data from 2,000 people and identified 1,400 pairs of friends. The scientists discovered that people share 0.1 % more DNA with their friends than with strangers.

INVISIBLE GRAFFITI FOUND IN ANGKOR WAT

↓ New method reveals more than 200 unknown murals.

ARCHAEOLOGY The magnificent Angkor Wat temple in Cambodia is adorned by great art from the 1100s, and now, 200 previously unknown works of art have miraculously been discovered.

During excavation of the temple area, Australian archaeologist Noel Hidalgo Tan happened to notice faint red and black pigments which occurred on several temple

walls. He photographed the pigments and processed the images digitally using sophisticated software, only to discover that the pigments originated from centuries-old mural paintings, an early type of graffiti.

In the 16th century, Angkor Wat was converted into a Buddhist shrine. According to Noel Hidalgo Tan, the mural paintings probably date back from this period.

ARCHAEOLOGISTS EMPLOY NASA TECHNOLOGY

Thanks to digital image processing technology developed by NASA, the American Space Agency, 200 mural paintings have become visible once again. The technology highlights and intensifies weak colours.

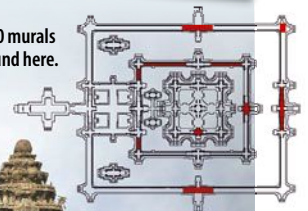
Photo taken with a powerful flash reveals traces of paint



After image processing, two elephants appear



200 murals found here.



Angkor Wat was built in the 1100s as a temple dedicated to Vishnu, a Hindu god.

NOEL HIDALGO TAN/ANTINQUITY & THINKSTOCK

► NEWS FLASH!

NEW NEURONS
ERASE MEMORIES

If you have forgotten your childhood, there may be a natural explanation. Scientists have discovered that new neurons can erase old memories. In an experiment, mice in a box were given electric shocks. In the following months, when the mice returned to the box, they showed signs of anxiety, which ceased, when the mice were given new brain neurons.

A newly discovered exoplanet orbits only one star in a binary star system.

NASA

ICE-COLD PLANET
ORBITS ONLY ONE TWIN

ASTRONOMY 3,000 light years from Earth, astronomers from the Ohio State University in the US have discovered an exoplanet orbiting one of the stars in a binary star system at almost the same distance as the one from Earth to the Sun. The discovery has attracted attention, as it is the first proof that Earth-like planets can be formed around closely spaced binary stars and orbit only one of the two mother stars.

The exoplanet, OGLE-2013-BLG-0341LBb, has twice the mass of the Earth, but with a

surface temperature of -213°C , it is too cold to support life. The cold is due to the planet's mother star being some 400 times weaker than our Sun.

A few years ago, astronomers did not believe that binary stars could have planets, but today, we know of several examples. The new discovery means that astronomers can broaden their search for habitable exoplanets.

EXOPLANET

An exoplanet - also known as an extrasolar planet - is a planet, which orbits a star other than the Sun. In recent years, astronomers have discovered several hundred planets in other solar systems.

LOCAL FOCAL POINT
South Dakota, USASearch for dark matter
below the ground

In an abandoned gold mine in South Dakota, USA, physicists are looking for dark matter, which makes up major parts of the universe, according to theory. With a super sensitive detector, the Large Underground Xenon Experiment, scientists have initiated a 300 day observation period.

C. FAHAMI/UC BERKELEY LAB

LACQUER MADE
WARRIOR PAINT STICK

Since the discovery of the 2,000-year-old terracotta army in 1974, it has remained a mystery how its creators made the colours stick to the surface. But now, scientists have discovered that the colours adhered by means of lacquer obtained from the laquer tree.

SHUTTERSTOCK



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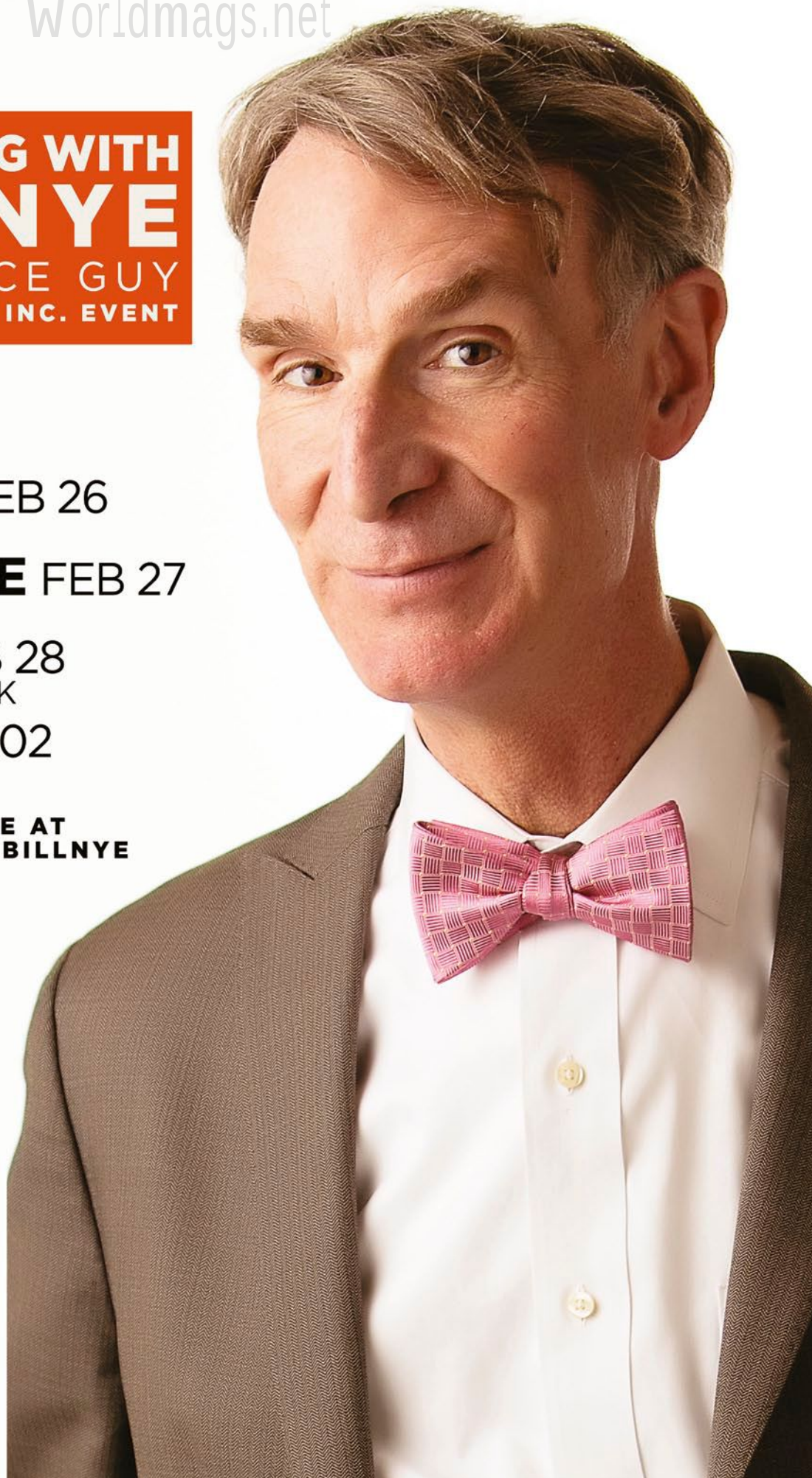
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▶ **30 kg**

is the weight that a new exoskeleton developed in South Korea can help shipbuilders lift.



SHARKS USE ALL SENSES TO HUNT

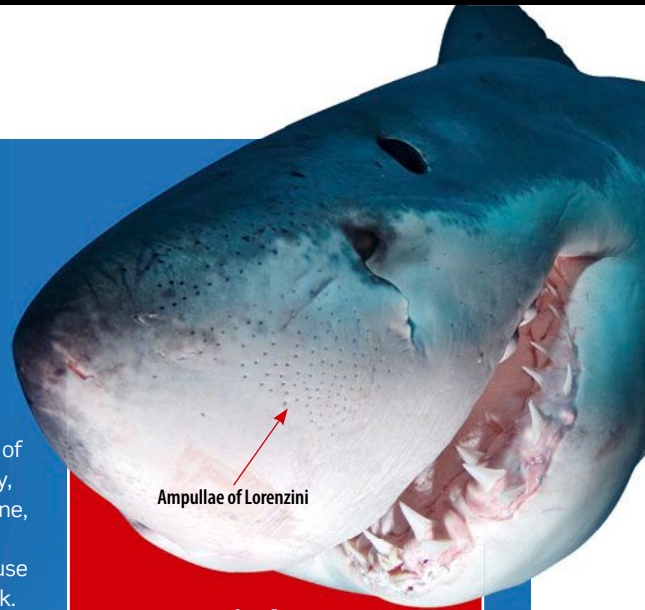
The predator employs all six senses to catch its prey.

ZOOLOGY Sharks are awesome hunters, but the exact way in which they locate and sneak up on their prey has always been a mystery. Now, scientists from the American University of South Florida have disclosed the secret during a six year study.

The scientists studied three species - the blacktip reef shark, the hammerhead shark, and the nurse shark - which had been captured and placed in separate tanks. The studies revealed that the animals make their highly sensitive senses interact in a sophisticated manner all through the different stages of hunting, and the method is basically the same, disregarding the species. From

a distance, the sharks use their sense of smell. When they are closer to the prey, they use their vision and their lateral line, which is a sense of touch measuring pressure variation. Finally, the sharks use their electric sense for precision attack.

As part of the study, the scientists deactivated one or more of the sharks' senses by for instance covering their snouts with an insulating material, so their electric sense was blocked. The sharks were largely able to compensate for the lacking sense by using another.



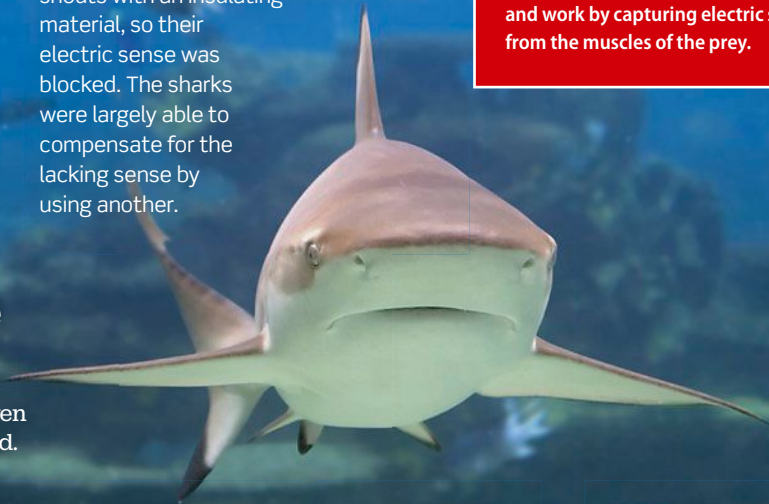
Ampullae of Lorenzini

Extra sense in the snout

Sharks have an electric sense located in the so-called ampullae of Lorenzini. The sensory organs are located on the snout and work by capturing electric signals from the muscles of the prey.

Use of senses depends on distance

When a shark hunts, it uses all its senses in sophisticated interaction. The shark is able to catch its prey, even when one sense has been deactivated.



1 SMELL

From a distance, the shark navigates by its sense of smell. It picks up even tiny scent trails, knowing where they come from.

2 TOUCH

When the shark is closer to its prey, its lateral line, slime-filled depressions with sensory hairs, registers shock waves from the prey.

3 VISION

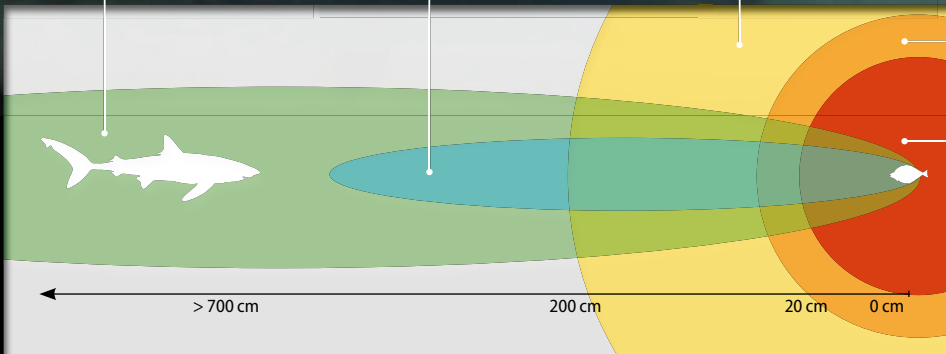
At close range, the shark navigates by means of its large, light-sensitive eyes.

4 HEARING

At very close range, the shark can hear noise in the water such as from a wounded animal that can be caught and consumed.

5 ELECTRIC SENSE

Right next to the prey, the shark's electric sense locates the prey, allowing the shark to make a very precise attack.



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Wireless energy – how?

Can power be transmitted without the use of cables, and is the technology available?

More than 100 years ago, one of the pioneers of electricity, Serbian-American super inventor Nikola Tesla, described how power can be distributed through the air. Today, we mostly transmit power via cables and wires, because the energy loss is huge unless sender and receiver are physically connected.

Several wireless systems already exist, such as in electric toothbrushes, in which a

magnetic field in the charger transmits power to a magnet in the toothbrush. Japanese car maker Toyota has also developed a plate that can charge electric cars parked on it. Wireless power is transmitted via two magnetic coils: a sender and a receiver. The sender converts the electric energy into a magnetic field, and the magnetic field in the receiver coil is converted back into power.

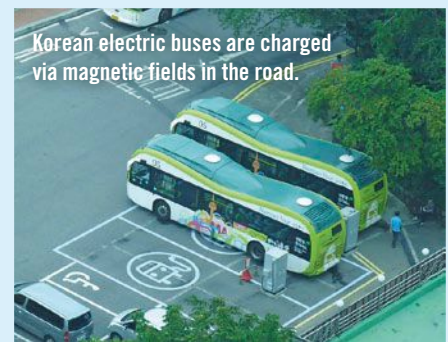
Scientists at the Massachusetts Institute of Technology (MIT) in the US have probably found a solution to the distance

problem: coils that can extract the energy from magnetic fields over a distance of several metres. The scientists have managed to transmit wireless power to a 60 watt light bulb over a distance of 2m – with an energy loss of 50 %. The scientists imagine that in the future, we will build coils into walls and place them under tables to avoid the trouble of cables. The magnetic field can pass through most materials and is about as weak as Earth's magnetic field. According to the scientists, wireless power poses no health risk.

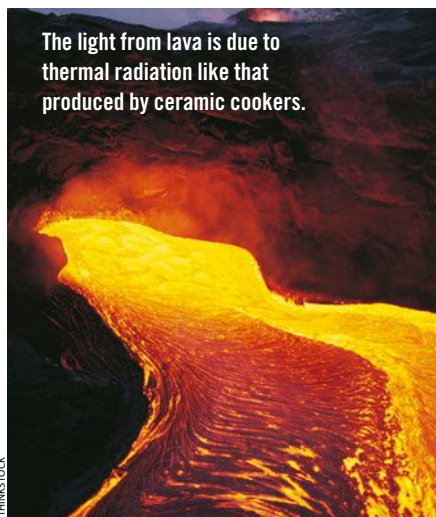


BUS POWERED BY WIRELESS ELECTRICITY

In South Korea, a number of electric buses are powered by magnetic coils in the road. The motion of the bus activates the coils, which transmit 100 kW to the bus. The gap between the coil and the belly of the bus is only 15-18 cm, and the short distance means that the bus can utilise approximately 85 % of the energy. Longer distances involve much more energy loss.



Korean electric buses are charged via magnetic fields in the road.



The light from lava is due to thermal radiation like that produced by ceramic cookers.

How can Earth's interior burn without oxygen?

Earth's interior is not burning in the traditional sense of the word. Burning is explosive oxidation, and the process cannot take place in Earth's interior, where there is no free oxygen. We describe Earth's interior as "red-hot", because hot material emits thermal radiation, which in turn emits visible light.

Earth's interior consists of liquid rock or magma. At temperatures over 1,400 °C, magma is white-hot, but as it cools down, it changes colour. At a temperature of around 1,300 °C, it is yellowish, at 900 °C, it is orange, and at 700 °C, the colour changes to red. The thermal radiation leaves the visible part of the spectrum and becomes infrared at around 450 °C, after which the lava appears black.

Temperature	Colour radiation of lava
480 °C	Weak red glow
580 °C	Dark red
730 °C	Bright red or orange
930 °C	Bright orange
1,100 °C	Weak yellowish/orange
1,300 °C	Yellowish/white
> 1,400 °C	White

TOP5

WHICH EPIDEMIC WAS THE MOST LETHAL?

1. **Smallpox**
≈ 300 million lives claimed.
2. **Measles**
≈ 200 million lives claimed.
3. **The Black Death (plague)**
≈ 100 million lives claimed.
4. **Spanish flu**
≈ 50-100 million lives claimed.
5. **HIV/AIDS**
≈ 25 million lives claimed.

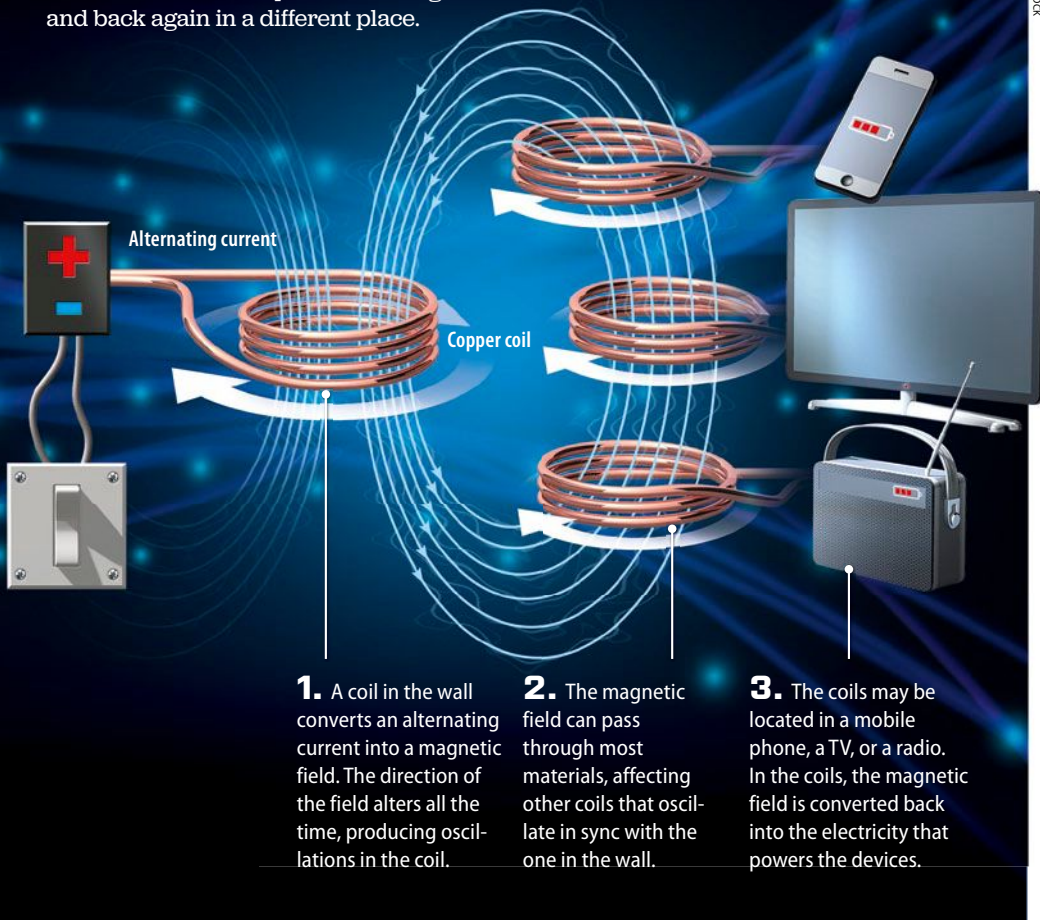
On a global scale, smallpox caused the most deaths.



THINKSTOCK

Future homes will be wireless

Soon, electricity will be transmitted wirelessly. The aim is to convert power into magnetism and back again in a different place.



CLAUS LUNAU / SHUTTERSTOCK

IN SHORT

THE OLDEST ROAD?

The road to Giza, Egypt, is the oldest cobblestone road. The Egyptians built the road about 4,600 years ago and used it to carry huge stone blocks to Giza, where pyramids such as the Great Pyramid were built. The road is two metres wide.



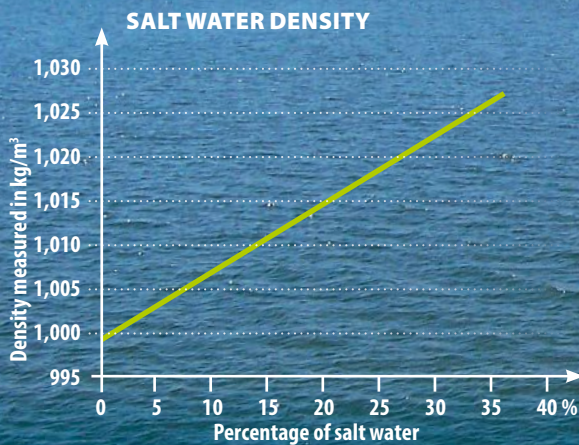
WHY DO CORN KERNELS COME OUT WHOLE?

The "skin" of corn kernels consists of tough plant fibres, that are also found in the "skin" of beans, peas, and tomatoes. The fibres consist of cellulose and make up the main constituent of cotton and wood. The human digestive system has no enzymes to digest and break down cellulose fibres. So, the body cannot break down corn kernels, that pass through our guts undigested.

ALAMY/IMAGESELECT

NATURE IN PRACTICE

Density differences may mean that salt water (left) and fresh water (right) will not mix.

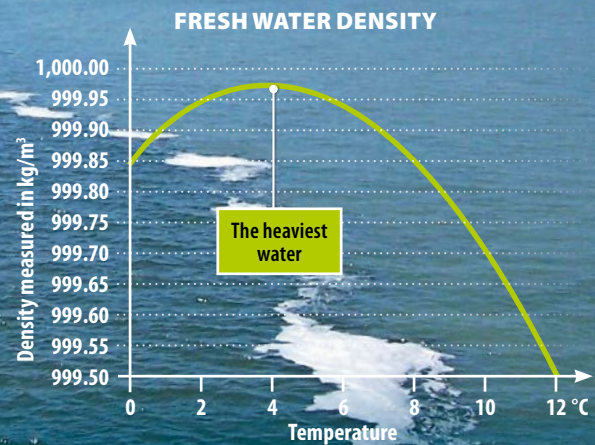


SALT MAKES WATER HEAVIER

The more salty water is, the heavier it becomes. This is due to two factors: 1) the salt is heavier than the water molecules which it replaces. 2) Salt packs densely with the water. So, salt water is more dense than water and salt individually.

WHY DOES WATER SOMETIMES FORM LAYERS?

Fresh water features the greatest density at four degrees, as the water molecules are densely packed at this temperature. Higher temperatures produce more mobile molecules, i.e. there is room for fewer of them. One litre of scalding hot water weighs slightly less than one litre of 4-degree-warm water. The salt content also affects the density of water.



WATER IS THE HEAVIEST AT FOUR DEGREES

Water weighs the most at a temperature of four degrees, as the molecules are free and move very little. At temperatures lower than four degrees, the water molecules freeze into a crystal grid, taking up more room and reducing density.

WHO DISCOVERED RUBBER?

Rubber is used in everything from rubber boots to condoms. But who used it first, and for what?

The first people to extract the juice or latex of the rubber tree more than 3,500 years ago were the Indians of Mexico and Central America. They used the rubber to make sandal soles, rubber bands, rubber statues, and solid balls which were used for ceremonial ball games. When the Europeans arrived to Central America in the 1400s, the rubber production had already been an industry for a long time. 16,000 rubber balls per year were manufactured.

BALLS: Scientists have found several old balls during excavation in Central America. Some of them only measure a few cm, while others are the size of soccer balls. The oldest ones are from around 1600 BC - that's more than 3,600 years old.



TYRES: In 1839, Charles Goodyear of the US invented the retreading process, making natural rubber dimensionally stable, and soon rubber tyres were introduced.

How powerful is a great white shark bite?

A great white shark has a very powerful bite – twice as powerful as the biggest croc and more powerful than that of a T. Rex. Humans bite with a force of 700 newtons, white sharks with

→ **18,000 newtons**

IN SHORT

WHY DO WE YAWN?

Scientific research indicates that yawning expands sinuses in the upper jaw, so air is pumped into the brain. The air cools the brain and prevents overheating. When you are tired, the system keeps your brain alert.



WHY ARE ELECTRIC KETTLES SO NOISY?

A few seconds after the activation of an electric kettle, the first air bubbles form at the heating element. The bubbles move upwards, but as the overlying water is still cold, the bubbles collapse on their way up. The collapsed bubbles leave a void that is immediately filled by colder water. The water motion produces the sound. The noise drops when all water boils, as the bubbles survive the passage up through the water.

SHUTTERSTOCK

THINKSTOCK, CLAUUS LUNAU

ARE CANDLES UNHEALTHY?

Candles are often made of paraffin, which is a chemical compound that only consists of carbon and hydrogen. As the candle burns, the hydrocarbons react with the oxygen of the air, ideally turning into water, carbon dioxide, heat, and pleasant light.

A quietly burning candle flame will not harm our health. Indeed, a new Swedish study indicates that quietly burning candles could strengthen the heart. Stearin and paraffin produce healthy sodium and

potassium salt vapour, which can be absorbed in the blood. The vapour derives from impurities in the candle and from flame retardants in the wick.

If the candle is subjected to draught, making the flame flicker, unhealthy soot particles are produced. The particles are so tiny that they can penetrate the lungs and enter the body, where they may cause cancer. Soot is observed as smoke and is produced, because the combustion is incomplete.

Flickering candles are unhealthy

Candles may be harmful, if they flicker, as this will produce unhealthy soot.

Real stearin is the best

A study demonstrated that paraffin gives off a lot more potentially cancer-causing substances than candles made of stearin or bees' wax. The burning temperature of paraffin candles is not high enough, so more molecules whose combustion is incomplete are given off.



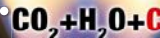
THINKSTOCK

IDEAL FLAME

3. If the flame burns quietly, the soot particles will turn into CO_2 higher up in the yellow zone.



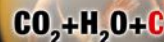
2. At the bottom of the yellow zone, the paraffin is combusted into carbon dioxide, water, and carbon particles, also known as soot.



1. The heat from the candle makes paraffin, $\text{C}_{31}\text{H}_{64}$, evaporate in the blue zone.



UNHEALTHY SOOT



4. If the flame flickers, the soot particles do not burn up.



Why do flamingos stand on one leg?

Just like a number of other birds, flamingos have an outstanding (heh) ability to stand on one leg for long periods of time. Some bird species can even sleep in this position. Flamingos stand on one leg for two reasons: to rest the other leg and for temperature regulation purposes. In cold weather, the birds lose a lot of heat through

their long, thin legs, particularly when standing in water. But when one leg is positioned close to the body, the heat loss is reduced. So the birds tend to stand on one leg when it is cold.

Flamingos can lock their foot joint to stand in a more stable position. So, they need not worry about keeping their balance, when they sleep.

Strange animal sleeping positions

Many animals rest or sleep in strange positions. The position may seem painful and unpleasant to a human being, but the animal's body is designed to make it relax in it.

HORSES Thanks to customised joints in the legs that lock in a vertical position, horses can sleep on their feet.

BATS The tendons in the legs and feet of bats are positioned in such a way that the toes are automatically tightened by the animal's weight, when it hangs by its feet. So, bats need not use strength to hold on.

SLOTHS The long claws of sloths grow out to form natural hooks. Consequently, the animal needs not use strength to hang from the branches of trees – it happens automatically.

LOCKED KNEES

FIRM GRIP

HOOKEED CLAWS

A FLAMINGO STANDING ON ONE LEG

keeps its balance by leaning to the same side as the supporting leg. Moreover, it rotates its body around its long axis, so the centre of gravity is located directly above the supporting foot.

WHAT IS THE DIFFERENCE BETWEEN FOG AND MIST?

If visibility is good - more than 1,000 m - the weather phenomenon is called mist. But if visibility is poor - less than 1,000 m - it is known as fog. Both mist and fog occur because the clouds are located at the surface of the Earth. Clouds consist of microscopic droplets which are so light that they float. Many small droplets affect visibility.

IN SHORT

WHAT IS DIALYSIS?

If the kidneys fail, the blood must be cleansed artificially in a process known as dialysis. The blood flows past a membrane that only lets tiny molecules pass. Red blood cells remain in the blood, but urea is extracted.

What became of the Tenth Planet?

In 1987, astronomers make discoveries which give reason to believe that our Solar System contains an extra, tenth planet. But did they find it? And what has happened in the field since then?

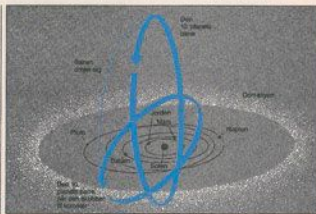
Solsystemets 10. planet kommer på tværs af de andre

Astronomerne ved nu, at der må findes en 10. planet. Men endnu har ingen set den...

Signaler fra de to gamle amerikanske rumsonder Pioneer 10 og 11 tyder nu på, at der findes en 10. planet i vores solsystem. Den ukendte planet må være fem gange tungere end Jorden og have en meget aflang elliptisk bane, som ville vinkles på alle de øvrige planeters bane.

Endnu har ingen set den nye planet, og ingen ved, at den findes, er stadig i tvivl. Men både gamle observationer og nye målinger giver gode fingerpeg om, hvor vi skal lede efter den 10. planet.

Altredes i perioden 1800 til 1900 fik man de første anvisninger af, at der måtte være endnu en planet. Dengang målte man afvigelser i både Uranus' og Neptuns bane, som måtte skyldes en hidtil ukendt planet. Gættede var blev Pluto opdaget i 1930, men den er for let til at påvirke



Den 10. planets bane står sandsynligvis vinkelret på de andres planethæder. Astronomerne mener desuden, at banevinklen af planeten kan variere. Chert-objekt og skibets kometer i gang.

NEW HEAVENLY BODIES FOUND

In 1987, Science Illustrated publishes a story about signals from the US space probes Pioneer 10 and 11 indicating that our Solar System includes an unknown planet. Old analyses of Neptune's and Uranus' orbits also indicate that a heavenly body disturbs the planets' orbits. Astronomers agree that a tenth planet exists. It only needs to be located.

Many dwarf planets such as Pluto and Eris have objects in their orbits that they have not removed. So, they are not planets.

A planet must meet three requirements

In 2006, the International Astronomical Union (IAU) laid down new standards for planets. They must:

1. Orbit the Sun without being the moon of another object.
2. Have enough mass to be spherical.
3. Be able to remove large objects in their orbits.

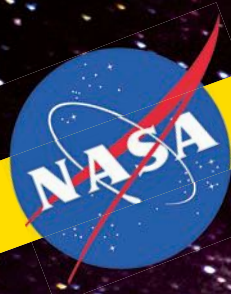
2014: New candidates knock at our door

In 2005, astronomers determined that a rather large object exists among the countless small ice objects on the outskirts of our Solar System. The heavenly body was named Eris. The newcomer, which is much bigger than Pluto, was photographed for the first time in October 2003. But due to distance, astronomers could not determine

its orbit and mass until 18 months later. Eris was categorised as a dwarf planet. In the early 2000s, astronomers found another two small objects in the Solar System, Sedna and Quaoar, which were also defined as dwarf planets. The same happened to Pluto in 2006. No object fits the description of a tenth Solar System planet. Indeed, the ninth

planet also still remains to be located now that Pluto can no longer claim the title.

However, the discovery of the VP113 dwarf planet in 2012 has lent hope that the outskirts of the Solar System involve a super planet that may be up to 10 times bigger than Earth. The search continues, as the ninth and tenth planets are probably out there.



DECEMBER 2014: ready for test flight

On 5 December, NASA's new venture, Orion, will be launched on its first test flight. The space capsule is the first step towards the reintroduction of long, crewed space flights. Launched by the most powerful rocket ever made, Orion will one day be heading for Mars.

By Antje Gerd Poulsen



OUR RIDE TO THE STARS



THE FRAMEWORK for Orion's crew module was unveiled in 2012. The capsule is now ready for launch.



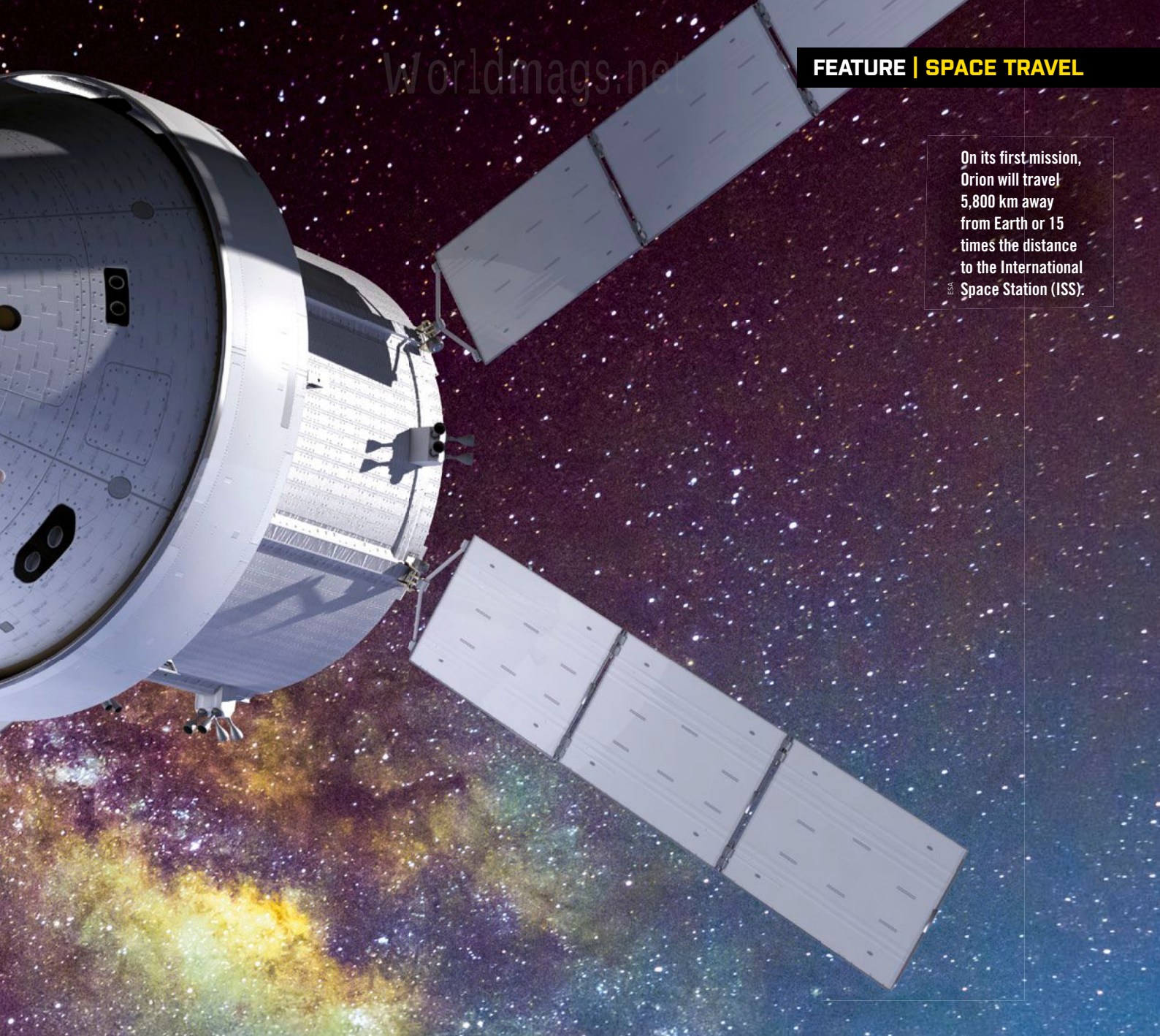
THE HEAT SHIELD only features 4.1 cm of insulation, but tolerates 2,760 °C. It sits under the crew module.



THE CREW MODULE measures 20 cubic metres, 9 of which are cabin space for the astronauts.

NASA

On its first mission, Orion will travel 5,800 km away from Earth or 15 times the distance to the International Space Station (ISS).



THE SERVICE MODULE holds the capsule's engines, that are designed to control Orion in space.



THE TWO MODULES can accommodate four astronauts on a 21 day space mission.



THE SPACE CAPSULE is launched on its first mission by NASA's most powerful rocket: the Delta IV.

HUGE ROCKET LAUNCHES ORION

On the 16th floor of the Kennedy Space Centre in Florida, USA, 84,000 pieces of wreckage from the Columbia space shuttle are stored. The shuttle exploded on 1 February 2003 above Texas shortly before landing, killing all seven crew members. The disaster was predicted during launch 16 days earlier, as a piece of insulation material broke loose, damaging the heat shield of one of the wings. With better procedures and equipment, the disaster may have been avoided.

When NASA's new venture, Orion, was launched on its first unmanned test flight on 5 December 2013, safety was the main focus. Orion is the American Space Agency's new space capsule, which will revive NASA's crewed space activities in the years to come. To begin with, the capsule will be sent on short missions such as to an asteroid near the Moon, but later, Orion will take astronauts to Mars. The Columbia experience has sparked a number of new safety measures. During launch, the capsule is attached to an emergency module that can get the crew out of harm's way in a matter of milliseconds, and upon entering the atmosphere, the capsule is protected by the biggest heat shield ever made.

Now, the NASA engineers know the safety measures work, as they were demonstrated properly during the first flight in December.

5,800 KM INTO SPACE

Orion was launched from the Kennedy Space Centre in Florida, USA, powered by a Delta IV Heavy rocket, which is the most powerful rocket that the US uses today. ►

**4,000
TIMES AS FAST:
ORION'S MAIN
COMPUTER VS
APOLLO'S**

The most powerful rocket ever made will launch Orion on future missions. If anything goes wrong, a launch abort system will separate the capsule with the astronauts from the rocket in a matter of milliseconds.

Booster rockets

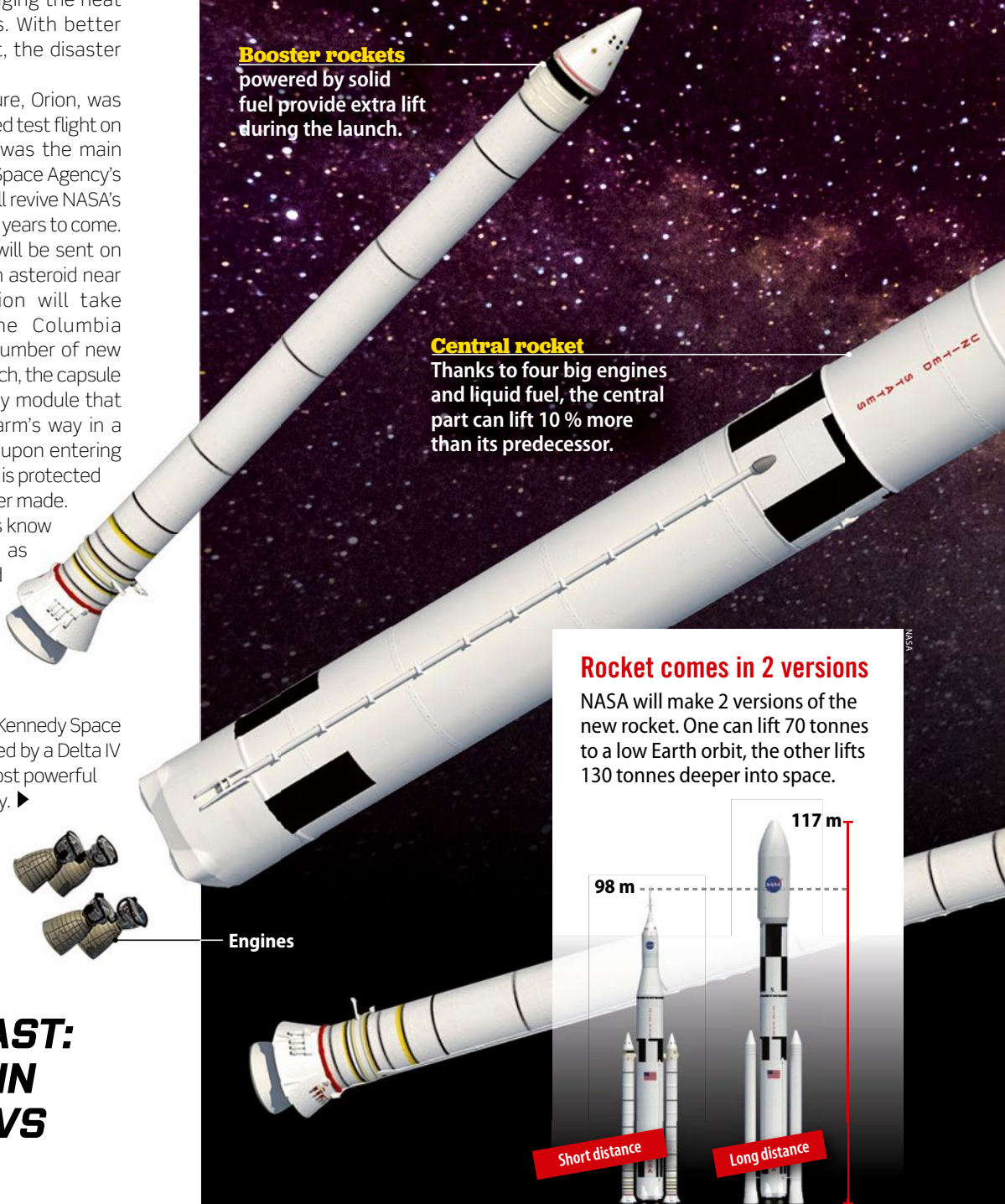
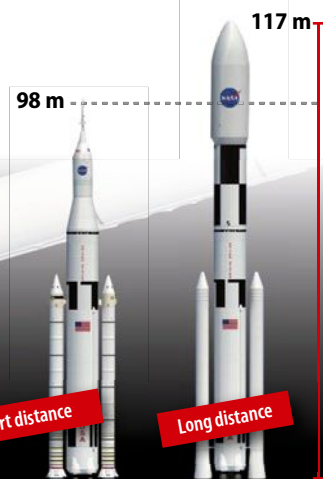
powered by solid fuel provide extra lift during the launch.

Central rocket

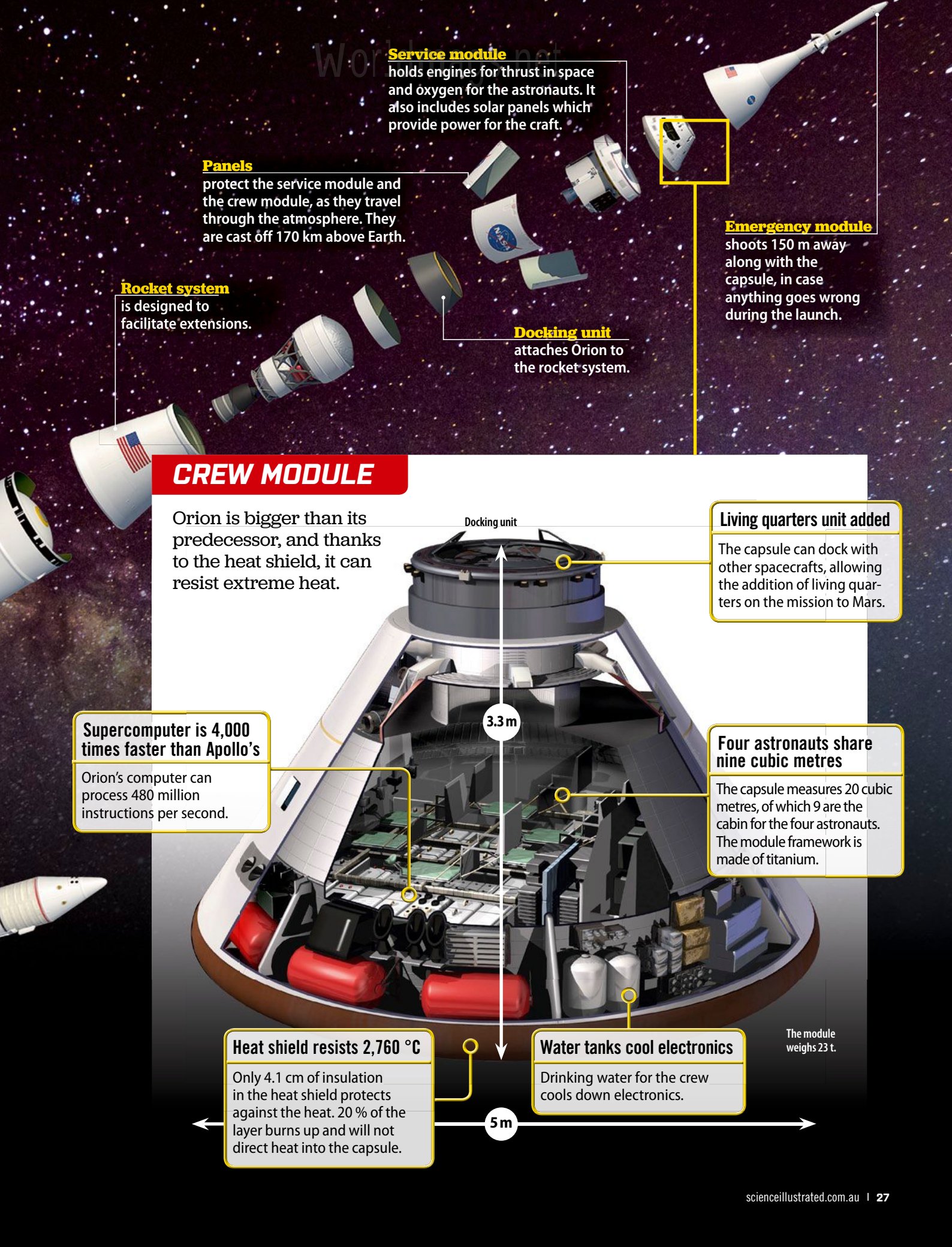
Thanks to four big engines and liquid fuel, the central part can lift 10 % more than its predecessor.

Rocket comes in 2 versions

NASA will make 2 versions of the new rocket. One can lift 70 tonnes to a low Earth orbit, the other lifts 130 tonnes deeper into space.



Engines



Service module

holds engines for thrust in space and oxygen for the astronauts. It also includes solar panels which provide power for the craft.

Panels

protect the service module and the crew module, as they travel through the atmosphere. They are cast off 170 km above Earth.

Rocket system

is designed to facilitate extensions.

Docking unit

attaches Orion to the rocket system.

Emergency module

shoots 150 m away along with the capsule, in case anything goes wrong during the launch.

CREW MODULE

Orion is bigger than its predecessor, and thanks to the heat shield, it can resist extreme heat.

Supercomputer is 4,000 times faster than Apollo's

Orion's computer can process 480 million instructions per second.

Living quarters unit added

The capsule can dock with other spacecrafts, allowing the addition of living quarters on the mission to Mars.

Four astronauts share nine cubic metres

The capsule measures 20 cubic metres, of which 9 are the cabin for the four astronauts. The module framework is made of titanium.

Heat shield resists 2,760 °C

Only 4.1 cm of insulation in the heat shield protects against the heat. 20 % of the layer burns up and will not direct heat into the capsule.

Water tanks cool electronics

Drinking water for the crew cools down electronics.

The module weighs 23 t.

3.3 m

5 m

6 MONTHS IS HOW LONG ORION CAN ORBIT THE MOON OR ANOTHER WORLD

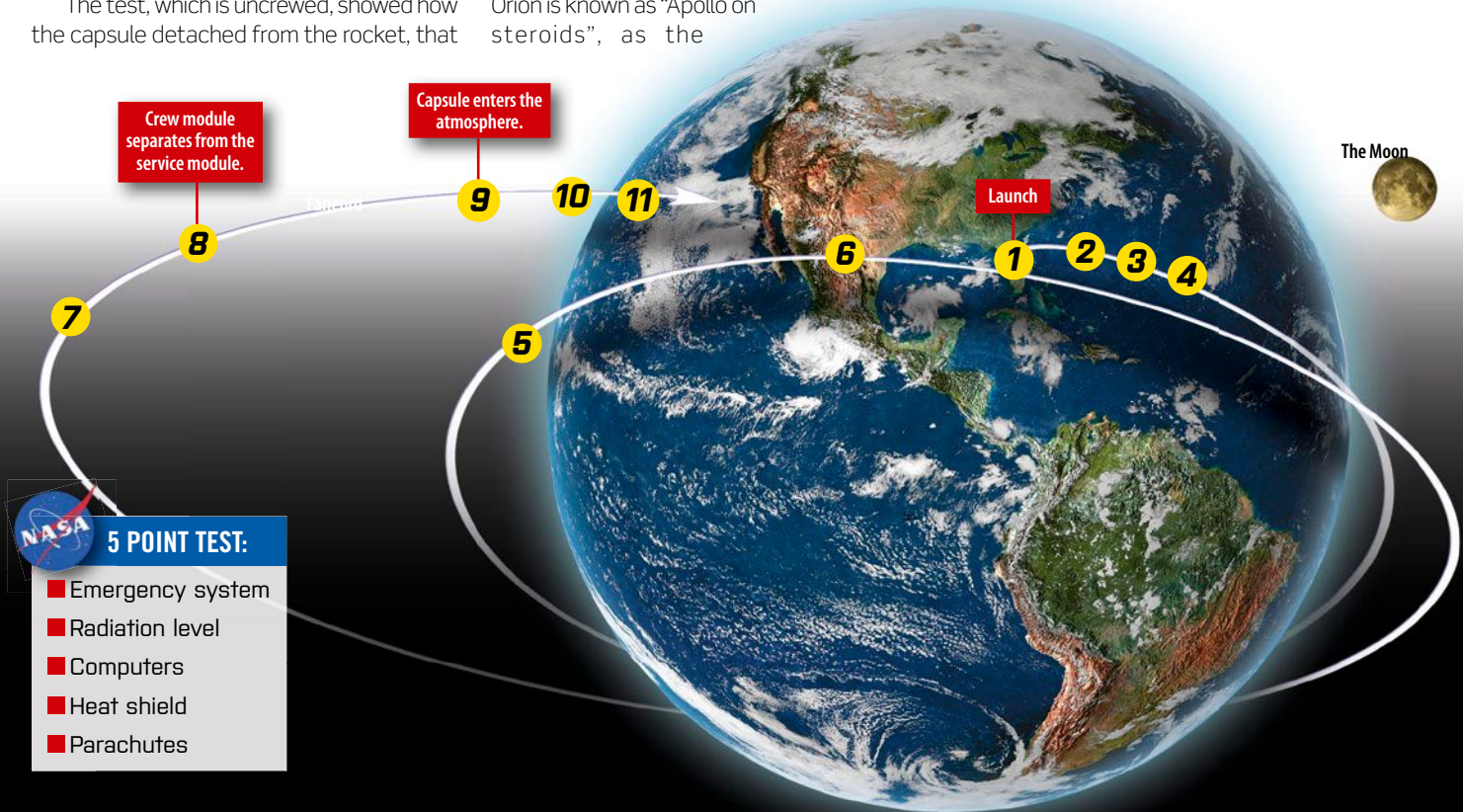
► On the mission, the spacecraft will orbit Earth twice. During the first orbit, Orion detached from the emergency module, but remained attached to the top stage of the Delta IV. Normally, the service module would take over powering the spacecraft. During the second orbit, the capsule travelled 5,800 km away from Earth. Finally, Orion dove back through the atmosphere at a speed of 32,000 km/h - 84 % of the speed that the capsule will travel at on its way home from a real mission. The Delta IV stage was discarded before re-entry.

The test, which is uncrewed, showed how the capsule detached from the rocket, that

the heat shield works, and how the electronic equipment functioned under extreme conditions. Sensors and cameras documented temperatures, radiation, and vibration. Another uncrewed flight is planned for 2018, during which NASA's new Space Launch System will be tested on a mission around the Moon. The first manned flight follows in 2015, and if all goes well, Orion will be heading for Mars in 2030.

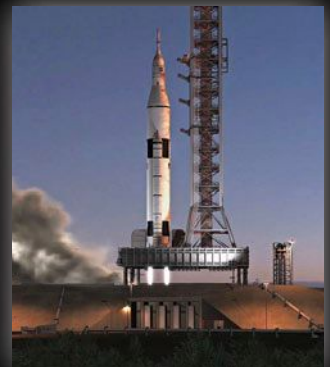
ORION IS APOLLO ON STEROIDS

Orion is known as "Apollo on steroids", as the



ORION TRAVELS 5,800 KM AWAY FROM EARTH

These illustrations show how Orion will launch on a typical mission. For its test flight, it remained docked to the upper stage of the Delta IV rocket and did not deploy its solar array. The service module was also a "structural dummy".



1. Orion is launched from Cape Canaveral in Florida, USA, on 5 December 2014.

space capsule resembles Apollo, which took the Americans to the Moon in the 1960s and 70s. Still, Orion is one third bigger and features much more powerful computers. Like Apollo, Orion is launched by a rocket and lands assisted by three parachutes in the Pacific, where a ship will recover it.

In spite of the similarities, the two craft are very different. Orion is both bigger and more technologically sophisticated than its predecessor. Particularly its computer power and electronics are in a league of their own.

Orion's computer is 4,000 times faster than Apollo's, processing some 480 million instructions per second. And instead of three astronauts, which Apollo could accommodate for less than two weeks, Orion can support a crew of four on an extended 21-day mission.

9,000 PEOPLE WORK ON THE PROJECT

The Space Launch System (SLS) is still in the development phase, but once the rockets are ready, they will take off aided by engines and booster rockets like the ones that launched the space shuttle. Some of the engines are even reused. But the new rocket system is still very special.

The SLS is made in two versions. The first one, which will be ready for its first test flight in 2018, will have 10 % more lifting power than NASA's Saturn V rocket, which launched the Apollo towards the Moon. The second version, which will be ready in 2015, will have 20 % more lifting power and be the biggest and most powerful space rocket ever made.

And rocket power will indeed be needed, when Orion travels deeper into space than any human being went before. Orion will not

only be exploring asteroids near the Moon, it will be going to Mars, far away from the Low Earth Orbit (LEO) which is just 160 km off Earth. The LEO is the zone in which the space shuttles flew, and where the International Space Station (ISS) is located along with some satellites.

Both the space capsule and the SLS are designed to be upgraded in sync with the pace of technological development. Orion will be furnished with a living quarters module and extra rocket power on a longer lunar mission or the mission to Mars, and it must also be possible to convert the capsule into a transport vehicle with a special cargo module.

More than 9,000 people are working on the project. The space capsule is built by the American company Lockheed Martin, the service module is made by the European Space Agency (ESA), and the launcher is developed by Boeing.

ORION WILL REDIRECT ASTEROIDS

The Orion test launch is NASA's first concrete step towards sending humans deeper into space since the final Lunar landing in 1972. Despite a 24-hour delay, the launch was more successful than Orion's existence so far, which has been beset by obstacles. Orion



The heat shield consists of a fine-meshed honeycomb with 320,000 cells filled with insulation material.

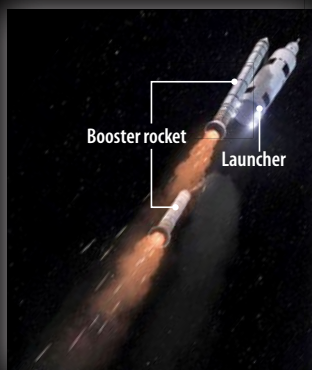


On its maiden voyage, Orion will land in the Pacific, so it is important to make sure that it can float!

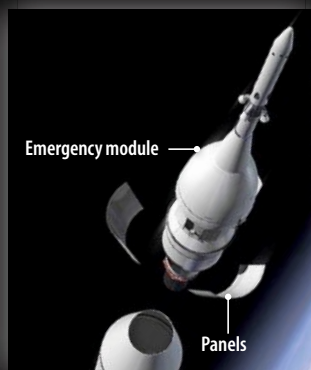
is the last remaining element of the Constellation space programme, which was initiated under President George W Bush, aiming to send humans to the Moon again.

In that programme, Orion was supposed to function as a transport craft going to and from the ISS.

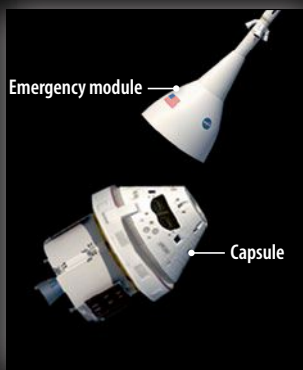
But the plans involving Orion have changed several times since then. The ►



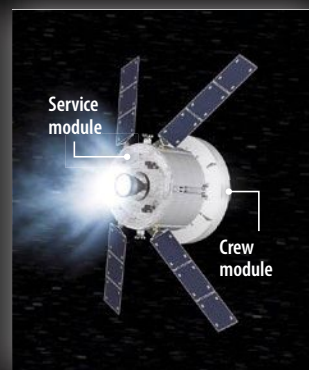
2. After four minutes, the booster rockets are detached, and soon after the launcher.



3. Subsequently, the panels protecting the capsule during launch are detached.



4. After six minutes and 20 seconds, the emergency module is detached.



5. The first set of service module jet engines are activated to power the craft.

21 days IS HOW LONG FOUR ASTRONAUTS CAN SURVIVE ABOARD ORION

► development of spacecraft by private companies such as SpaceX and Blue Origin means that Orion is no longer an ISS transport craft candidate.

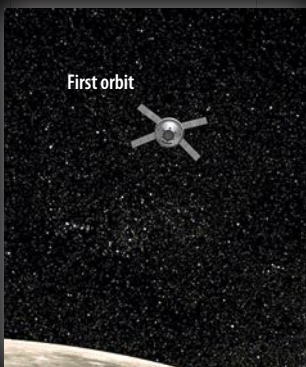
In 2010, American President Barack Obama cancelled the Constellation programme and set new space exploration targets: first asteroids – then Mars.

The most recent plans involve Orion as a part of NASA's Asteroid Redirect Mission, which aims to explore asteroids. The ultimate aim of the mission is to prevent Earth from being hit by an asteroid. So, Orion's first manned mission involves taking a closer look at an asteroid.

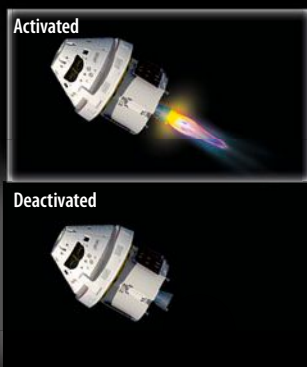
In 2019, a robotic spacecraft will capture a small asteroid or cut a piece of a 500 tonne asteroid and place it in a stable orbit around the Moon. Subsequently, Orion will dock with a robotic spacecraft in 2025, and two astronauts will take a space walk to study the asteroid and take samples of it.

Astronauts are already practicing for the mission at the bottom of a 12-m-deep swimming pool at the Houston Space Centre. Water eliminates gravity, and so, the swimming pool functions as a space

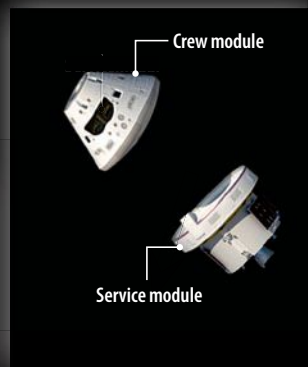
Three parachutes will land the capsule safely in the Pacific. Just like the buoyancy of the capsule, the parachutes have also been tested in advance.



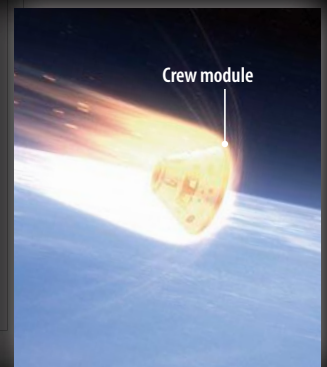
6. The jet engines are deactivated. The capsule enters its first orbit around Earth.



7. In the early second orbit, the second set of jet engines are activated and deactivated.



8. Before landing, the crew module separates from the service module.



9. The capsule enters the atmosphere in a blaze and at a speed of 32,000 km/h.

GOING TO MARS IN 15 YEARS?

After the test flights, Orion will explore an asteroid near the Moon before going to Mars.

SHUTTERSTOCK

2014

EXPLORATION FLIGHT TEST-1

Unmanned test

ROCKET: Delta IV Heavy rocket.

AIM: Testing disengaging, electronics, heat shield, and parachutes.

2018

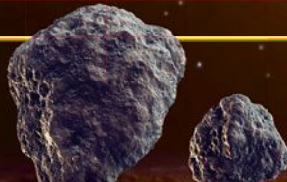
EXPLORATION MISSION-1

Unmanned lunar mission

ROCKET: Space Launch System.

AIM: Testing the SLS system.

DURATION: 3+ weeks.



EXPLORATION MISSION-2

Manned mission to an

asteroid near the Moon

ROCKET: Space Launch System.

AIM: Exploring and retrieving a sample from an asteroid orbiting the Moon.

DURATION: 10-14 days.

2025

If all goes well, Orion will go on a manned mission to Mars.

**2030
MARS**

simulator. The astronauts walk on the outside of a copy of Orion, just like they would on a real space walk, making their way towards a robot and its asteroid catch. Once there, the astronauts will use different equipment to take samples, while engineers dressed in diving suits observe how the exercise is turning out.

FINAL DESTINATION: MARS

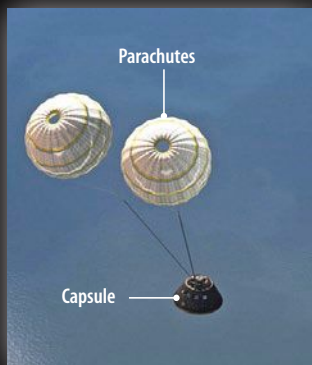
Mars is still Orion's ultimate aim, though the

size of the capsule, 9 m³ for four astronauts, is not the most convenient for a space mission lasting more than one year.

So, NASA must develop a residential module and a cargo module that can be attached to the capsule along with extra rocket power and equipment for landing on Mars. In terms of safety, a Mars mission also requires better protection of the astronauts against cosmic radiation, which will be much stronger than on missions closer to Earth.

Because of this, the Mars plans are still far off in the future. According to NASA, they will not be carried out until after 2030.

At that time, Orion may have been outdistanced by private Mars projects or new technological breakthroughs. Whether Orion will go all the way to Mars remains unknown. For now, the craft must prove that everything works, so the first astronauts can safely enter the cockpit and be launched on the first manned mission in 2025. **sci**



10. Two parachutes reduce the speed of the crew module to 32 km/h.



11. 4 hours and 24 minutes after launch, the capsule splashed down successfully in the ocean.



MM



Microscopic animals specialise in humans

Biologists have mapped out the wildlife of all remote corners of the world, but an almost unknown world exists literally right under our noses. A group of scientists went through 50 homes in North Carolina, USA, with a fine tooth comb, discovering an average of 100 species in each house.

The tiny animals thrive indoors in our midst, where there is plenty of food, moisture, and hiding places.

Surprisingly, the level of cleanliness had no particular influence on the microscopic fauna. And in homes, where insecticides were regularly used, scientists found an impressive biodiversity.

YOUR HOME IS FULL OF MONSTERS

American scientists, who went small game hunting in 50 ordinary homes, found a huge biodiversity. The creepy-crawlies spoil food, tear houses apart, and feast on our bodies.

By Rasmus Kragh Jakobsen



THE DESTRUCTIVE

With its big head and strong jaws, a termite can consume all types of wood.

TERMITE

- **SIZE:** 2-10 mm
- **HABITAT:** Woodwork
- **LIFE SPAN:** 1-2 years (queens up to 50 years)

- **FAVOURITE FOOD:** Wood
- **CONTROL METHOD:** Insecticides such as boric acid

Tiny animals undermine house foundations

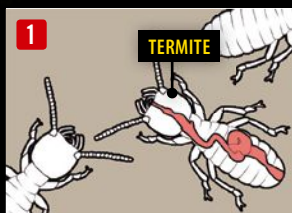
Termite colonies may include millions of individuals. The tiny creatures feed on wood, and their appetite is so voracious that they can consume most of the woodwork of a house, undermining materials, and possibly making homes collapse in the end. Termites are so troublesome, as

unlike many other insects, they are able to digest wood aided by bacteria.

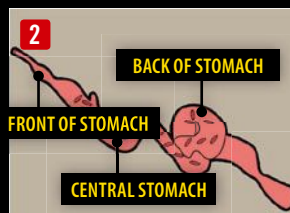
Several teams of scientists have been inspired by termite stomachs in their efforts to develop a similar system, in which enzymes break down wood chips into sugar. If they succeed, we will have an efficient biofuel production method.

SAWMILL CONVERTS WOOD INTO SUGAR

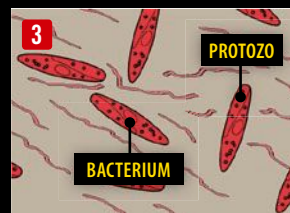
Wood primarily consists of cellulose, which is hard to digest. But cellulose is made of glucose molecules (sugar), and thanks to stomach bacteria, termites can break down the cellulose into nourishment.



1 Termites chew the wood into small bits, that are passed on in the digestion system.



2 At the back of the stomach, the wood is consumed by monocellular protozoa.



3 Inside the protozoa, bacteria produce enzymes that break down the wood.

BARKLOUSE

- **SIZE:** 1 mm
- **HABITAT:** Books, food
- **LIFE SPAN:** 6 months
- **FAVOURITE FOOD:** Flour, paper
- **CONTROL METHOD:** Moisture reduction, cleaning

Lice swallow literature

In 95 % of all homes, scientists found barklice, which do not bite, but on the other hand, they consume anything edible such as book covers, rice, grain, and starchy materials, including paper.

Genetic studies have recently determined that the barklice are of the same origin as head lice. Barklice need to be able to chew and have efficient mouth parts, whereas head lice have become such specialised bloodsuckers that they have lost their chewing mouth parts.

MOUTH

Unlike bloodsucking insects, the louse can chew and munch.

EYES

The animals do not really need eyes and have poor eyesight.

HIND LEGS

The strong hind legs allow the lice to jump onto new "meals".

BODY

The body is flat and easy to fit into cracks and books.



POWER AND STREED/SP/SCANPIX, S. GSCHMEISSNER/SP/SCANPIX, THINKSTOCK

The deathwatch beetle attracts a mate by knocking its chest fast against wood 8-10 times.

Death watch a bad omen

The deathwatch beetle's tapping, known as death watch, can be heard on quiet summer nights. According to popular belief, it foretold death in the family.



WOOD BORER

- **SIZE:** 4-18 mm
- **HABITAT:** Wood
- **LIFE SPAN:** A few weeks (larvae many years)

- **FAVOURITE FOOD:** Wood, paper
- **CONTROL METHOD:** Wood preservation, heating to 55 degrees

Wood borer eats furniture

Old furniture such as items bought at garage sales often function as Trojan horses, allowing wood borers access to your home. Usually, the attack will reveal itself by bore dust falling from the furniture, as the larvae munch through your bureau.

The larvae are hard to combat, as they work their way deep inside the wood, possibly remaining there for 10 or more years. Depending on the species,

the larval stage can last up to 12 years, during which period the larvae undermine the furniture, making their long passages, so the wood is finally completely porous.

Wood borers can also attack the woodwork of houses, but they love moisture, so modern, dry homes are unattractive. The pests mostly live in fuggy places such as roof slopes and crawlways. Today, most wood is now treated in ways that make wood borer access difficult.



Wood borer larvae undermine the wood, and though they are soft, they can easily work their way through the wood thanks to efficient jaws.

CLAUS LUNAU



ADULT WOOD BORER
Adult wood borers fly to woodwork, where they mate, and the female lays eggs.



EGGS
The egg is placed in cracks in the wood, where it is relatively safe from enemies.



LARVA
The soft larva slowly works its way through the wood, in which it can live for years.



PUPA
The transformation from larva to adult happens near the wood surface.

CARPET BEETLE

- **SIZE:** 3 mm
- **HABITAT:** Carpets, upholstery
- **LIFE SPAN:** A few weeks (larvae several years)
- **FAVOURITE FOOD:** Leather, wool, silk
- **CONTROL METHOD:** Vacuum cleaning, cleaning, bug spray

Beetles feast on our leftovers

Only very few homes do not include carpet beetles. The animals have adjusted to a diet of materials with which we surround ourselves. Particularly carpets, clothes, and upholstery fabric are popular with the larvae, which may also consume musical instruments that have been put away. However, the animals also have a positive function as garbage

collectors, removing dead insects, spilt food, and even cut off toe nails from carpets and furniture.

In natural history museums throughout the world, carpet beetles are both dreaded and loved. Scientists utilize the bugs' healthy appetite to turn dead animals into skeletons, but the beetles can also destroy entire collections, if they get out of control.

Hair keeps spiders away

Carpet beetle larvae are covered in lots of bristly hair. The hair prevents spiders from biting or capturing the juicy larvae in their webs.



The beetles' club-shaped antennae are important sensory organs that can be used to navigate otherwise confusing carpets.

MOTH

■ **SIZE:** 6 mm
 ■ **HABITAT:** Wardrobes
 ■ **LIFE SPAN:** 30-90 days

■ **FAVOURITE FOOD:** Textiles, fur
 ■ **CONTROL METHOD:**
 Dry cleaning, insecticides



Moths have adjusted to a life among fabrics such as cashmere wool.

Larvae grow up in wardrobe

A moth flickers out of the wardrobe, and the insect, which has consumed a sweater, is immediately shooed away. But in fact, it is not adult moths, but rather their larvae, that are responsible for the clothes massacre.

Adult moths have finished eating long ago, and they are only looking for a mate and somewhere to lay their eggs, for which purpose wardrobes are perfect. The larvae love textiles and even end up using fibres from the clothes to spin a pupa.



STEVE GOSCHMIESNER/SP/SCANPIX

SILVERFISH

■ **SIZE:** 10 mm
 ■ **HABITAT:** Cracks and crevices anywhere in the house, not least the bathroom

■ **LIFE SPAN:** 4 years
 ■ **FAVOURITE FOOD:** Crumbs, starch
 ■ **CONTROL METHOD:** Cleaning

Bathroom top sprinter is a night owl

Silverfish have hardly changed since the time of the dinosaurs. Their design is optimised for life underground, from where they rarely emerge.

The design has also proven efficient for living close to humans, natural cavities in the ground being replaced with the nooks and crannies of private

homes. The animals emerge in the cover of darkness, particularly in moist places such as bathrooms and basements.

The versatile creatures will eat nearly anything organic and happily feast on carpets, books, wallpaper, and glue. They have neither poison, nor strong armour, but can flee fast thanks to their long legs.

BODY

The flat animal is able to pass through even tiny cracks.

EYES

Small eyes and poor eyesight indicate a life underground.

Silverfish thrive in cracks and crevices that are similar to their natural habitat.

CERI

When mating, the male and female use these for contact.

SCALES

Scales make it hard for predators to seize silverfish.

LEGS

The animals can flee enemies fast, but they cannot jump.

STUART WILSON/SCANPIX

Scientists' 3 favourites

Among the hundreds of species, scientists found in private homes, Matt Bertone was particularly fascinated by 3 unusual species.

TELEPHONE POLE BEETLE

The beetle has a bizarre life cycle, involving that males eat their mothers. Why they do so remains a mystery to scientists. The beetle is the only surviving species of the extinct Micromalthidae family.

ANT-LOVING CRICKET

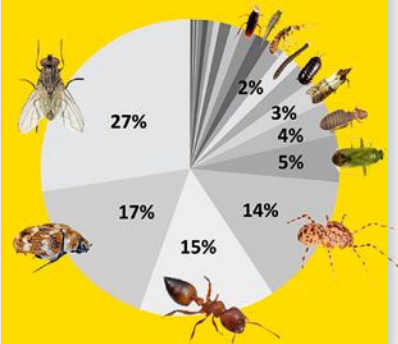
The animals usually live together with ants in their nests and rarely emerge. Nevertheless, Matt Bertone found several dead ant-loving crickets in kitchens. They had possibly been dragged away by ants which were clearing their nest of dead bodies.

SPITTING SPIDER

The spiders catch their prey using a special technique. They sneak up on the prey, and thanks to fast jaw motion, they spit a zigzag flow of silk and poison on it. Subsequently, the spider can suck the fluids of the victim unhurriedly.

A majority of flies

The scientists collected some 10,000 animals in 50 homes. The majority were flies, followed by beetles, ants, and spiders. One single room held more than 20 species of flies.



THE DISEASE-CAUSING

FLEA

- **SIZE:** 1-5 mm
- **HABITAT:** Living creatures
- **LIFE SPAN:** 2-3 months

- **FAVOURITE FOOD:** Blood (adults), organic material, and faeces (larvae)
- **CONTROL METHOD:** Flea poison

Jumpers transmit virus and microbes

Fleas were responsible for the worst epidemic in world history – the Black Death, which killed approximately half of Europe’s population in the mid-1300s.

The bubonic plague was caused by a bacterium which was probably transmitted by rat fleas, and in modern times, animal fleas can also transmit many unpleasant things. Dog and cat

fleas spread worms, spotted fever, and a number of different viruses.

Fleas are categorised depending on their hosts, and there are more than 2,000 different species. But unlike the picky lice that will always stick to one species, fleas happily drink a cocktail of blood from any animals or humans in the vicinity.

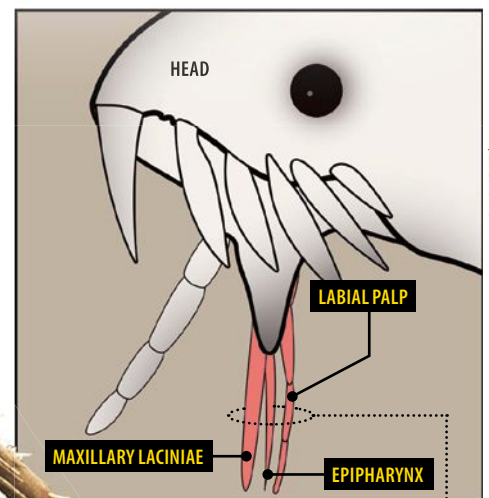


SCANPIX

Fleas are not picky and will happily jump from one host to another. Thanks to their powerful take-off, they can jump up to 30 cm.

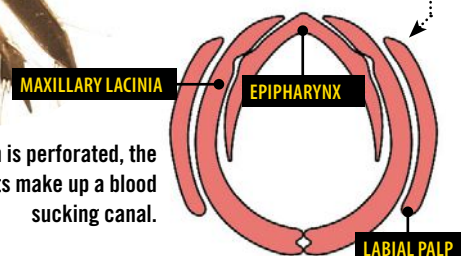
Specialist drinks blood with straw

The mouth is equipped with five parts, which make up an efficient sucking tool. Two maxillary laciniae penetrate the host’s skin, and the epipharynx is entered into a blood vessel. The blood is sucked up through a “straw” made up by the maxillary laciniae and epipharynx supported by two labial palps. The suction is produced by negative pressure, caused by throat muscles.



POWER & SYRVED/SP/SCANPIX, CLAUS LUNAU

Cross section of mouth parts



Once the skin is perforated, the mouth parts make up a blood sucking canal.

Fleas have adjusted to life on their hosts. They are usually brownish, as that is the most efficient camouflage.

Each gramme of dust in cloth and linen usually holds 100-500 mites.

HOUSE DUST MITE

- **SIZE:** 0.2 mm
- **HABITAT:** Carpets, curtains, beds
- **LIFE SPAN:** 3-5 months
- **FAVOURITE FOOD:** Hair, body scales
- **CONTROL METHOD:** Moisture reduction

Mite kills us with its horrible poop

Each of us casts off 10 g of dead skin per day – the favourite food of house dust mites. The mites themselves are no problem, but their microscopic faeces particles are the most common cause of allergy and asthma. Globally, some 300 million people

suffer from asthma, and the disease causes approximately 250,000 deaths a year.

House dust mites, which are so tiny that they cannot be seen with the naked eye, love the stable environment of houses and exist in all private homes.



BED BUGS

- **SIZE:** 6 mm
- **HABITAT:** Beds
- **LIFE SPAN:** 2-10 months
- **FAVOURITE FOOD:** Blood
- **CONTROL METHOD:** Heat or cold

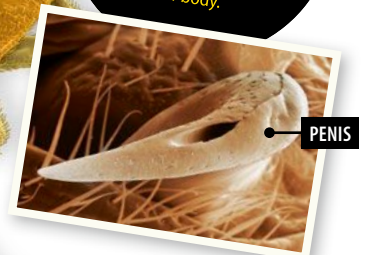
Vampire exploits sleeping habits

Bed bugs have always accompanied humans. Following a brief setback after World War II, the tiny bloodsuckers are gaining ground again all over the world.

The bugs have learned to be discreet, preferring to tap our blood during the night, resulting in bite marks and itchy rashes. Human blood lacks vitamin B, but the bugs get this important substance via a bacterium stored in a special organ. **SCI**



Bed bugs have bizarre sex
The male penetrates the female's stomach with his needle-shaped penis, ejaculating directly into her body.



Beyond the Emerald City

It's a vast wilderness only an hour's drive from Sydney, where dense forest leads to epic cliffs and sparkling beaches. If you haven't visited the Royal National Park since childhood, it's time to rediscover this amazing place.

Words and photography by Damon Wilder



Eucalypt Forest

Ubiquitous throughout the park, these hardy trees establish themselves in nutrient-poor sandy soil in the upper reaches of the valleys and the plateau.

There's no shortage of natural beauty in and around the greater Sydney area. As a Sydney-based nature photographer I have always been spoilt for choice with the Blue Mountains stretching dramatically to the west, Ku-ring-gai Chase National Park to the north and the Royal National Park sprawling majestically to the south. Over the years I have spent a huge amount of time exploring the Royal National Park and it has been a source of at least half of my collection of detailed close-up (or 'macro') photos of reptiles and arthropods.

My obsession for snapping photos of the macro world has taken me through a diverse range of habitats from dry scrubby plateaus rich in wildflowers to treacherous

► sandstone outcrops and ravines where colonies of nocturnal geckos seem to peek out of every crevice. Valleys of temperate rainforest line the waterways and even in the driest months of summer the sun barely penetrates some of the deepest canyons and ravines where the thick understorey of ferns and bracken is dominated by Turpentine trees and blackbutt interspersed with 20-metre cabbage tree palms. Local leeches are always too happy to nuzzle up and welcome you to their damp domain.

The Hacking river carves its way through the centre of the park as it flows from Helensburgh in the south through to Audley near the northern entrance, then finally out into the harbour at Port Hacking.

This part of the river has long been a popular recreation site for Sydneysiders. It is also around Audley and along the river walk that you have the best chance of spotting a large variety of birds, aquatic and otherwise. Swamp hens, cormorants and the obligatory ducks mingle with kookaburras and sulphur-crested cockatoos. As for their scaly relatives, lace monitors, eastern water dragons and eastern water skinks all frequent the river's edge. Even platypus live in these waters

▼ **Misty Forest**

On a rainy winter's day mist rolls through the temperate rainforest in the valley below National Falls. Even in the dry summer months the lower valleys remain lush and green, fed by the many streams that eventually converge on the Hacking River.



▲ **Sulphur Crested Cockatoos**

A gang of iconic Aussies gather for a drink and some socialising on the edge of the Hacking River.

► **Kookaburra**

The banks of the Hacking River are a haven for all manner of water birds and are particularly popular for some of Sydney's noisiest residents. Between the cockatoos and kookaburras the valley is constantly erupting in a cacophony of avian screeching and laughter.





Warratahs

The majority of the wildflowers in the Australian bush are quite small and easily missed on a stroll through the park. Not so when it comes to Warratahs that are among the largest and most striking - some on stems more than a metre high.



◀ **Streams**

flow through deep valleys of the Royal National Park creating a haven for lush temperate rain forest.

▼ **Lesueur's Velvet Gecko**

The rugged outcrops of sandstone are sometimes home to large colonies of broad tailed geckos (*Phyllurus platurus*) and Lesueur's velvet geckos (*Oedura lesueurii*).

though they are seldom seen in the busier areas. It is more likely that you encounter echidnas and wallaroos, and on rare occasions dingoes and even koalas.

Needless to say I thought I knew this park pretty well. When I started researching this national parks series however, I soon realised that I couldn't be more wrong. As it turns out after all these years I had completely neglected one of the most impressive elements of the park: the entire coastal stretch. Camera in hand I set out to rectify that and discovered some truly spectacular beaches sweeping between rugged weathered sandstone cliffs that soar to 100 metres in the southern part ▶



► of the park. The soft sandstone in places forms quite bizarre rock formations as aeons-old layers are gradually worn away by the wind and rain.

Queen Elizabeth II famously travelled past the park by train back in 1954, en-route to Wollongong. What she would have seen from her first class window is barely a hint at the diverse landscapes and ecosystems stretching for 15,000 hectares beyond the hills and to the edge of Tasman Sea beyond. Fleeting as her brush with the park may have been, it was clearly honour enough that what was formerly just known as the “National Park” gained a Royal in its name. But the park’s history dates back well before Queen Elizabeth was even born. Established in 1879, the park is not only the oldest in Australia but comes in a close second only to Yellowstone National Park for the title of oldest national park in the world.

So many of Australia’s natural wonders demand an epic journey before you reach them. The Royal National Park is only a short drive from Sydney, just 29 km south of the CBD. Why not head down this weekend? 

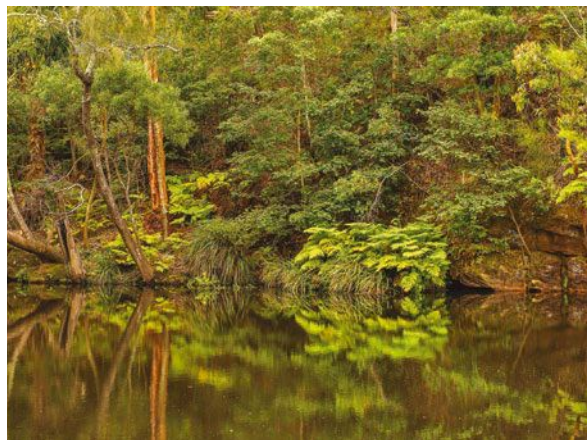
► **Eastern Water Skink**

The Eastern Water Skink (*Eulamprus quoyii*) is a common sight along the waterways of the park. They grow to 30 cm and when fully grown are known to be quite territorial as they defend prime hunting grounds. They are capable swimmers and have been known to catch small yabbies.



► **The River**

The Hacking River winds its way south to north through the entire length of the Royal National Park. A leisurely canoe paddle or stroll along the river bank is one of the best places to see a huge variety of birds and other wildlife.



Wedding Cake Rock

Like much of the coastal stretch of the Sydney Basin, the geology of the park is primarily sandstone. Wedding Cake rock and these neighbouring colourful sandstone formations are just some of the surreal visual highlights along the rugged 30 km stretch of coastline.

Garie Beach

This is one of the most popular beaches in the park. As is evident in the picture, Garie Beach is more of a wild surf beach than somewhere to take the kids for a casual dip in the ocean. But you can get a meat pie at the kiosk.



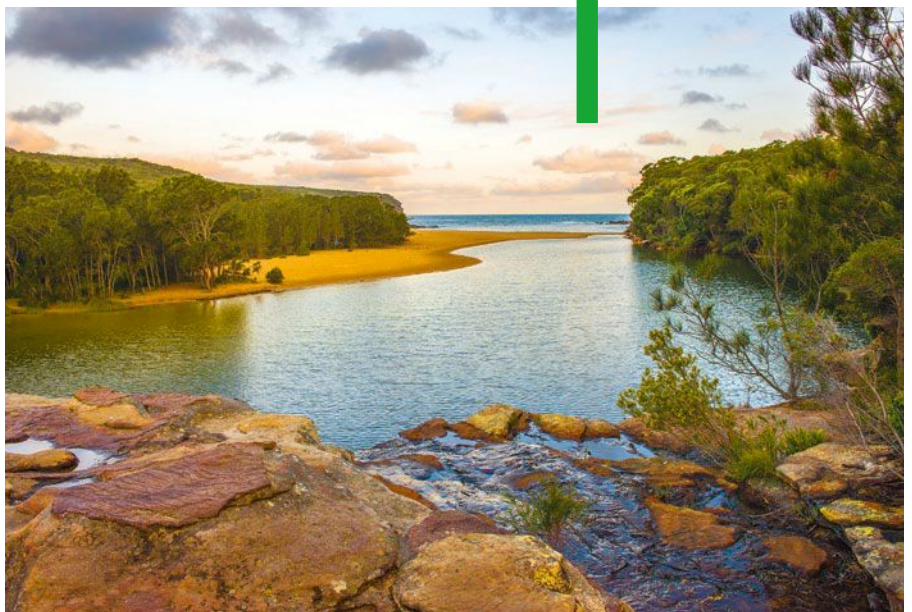
▼ Scribbly Gum

The scribbly gum with its invertebrate hieroglyphics has become something of an Aussie icon. The patterns on the fresh bark are trails left behind by the caterpillars of the scribbly moth, which munch their way through the soft cambium of the tree.



Wattamolla

With such an otherwise rugged coastline, the tranquil lagoon at Wattamolla beach provides something of a safe haven and has become one of the most popular family destinations in the park.



Science Illustrated reconstructs some of the most severe accidents in history. By the hour, we follow the people involved and explain the human errors and technical faults causing the fatal events.

BEHIND THE DISASTER

MONSTER WAVE CONSUMES EVERYTHING

On 26 December 2004, the planet shifts. An earthquake in the Indian Ocean sends a roaring tsunami off towards the coasts, and in a few hours, cities and holiday resorts are destroyed.

By Stine Overbye

AP/PHOTO

**WHAT?**

An undersea earthquake triggers a tsunami, which causes one of the worst natural disasters ever.

WHERE?

The tsunami hits the countries bordering on the Indian Ocean.

WHO?

About 230,000 people are killed, and more than a million lose their homes.

Mum, we need to get away from the beach. Now! I think a tsunami is coming." 10-year-old Tilly Smith and her family are spending their Christmas holiday on Maikhao Beach in Phuket, Southern Thailand. In the early morning of 26 December, she, her 7-year-old sister, and their parents have been sunbathing on the beach and playing in the lazy waves of the turquoise ocean, until Tilly notices that the ocean is behaving strangely, fizzing like soft drink.

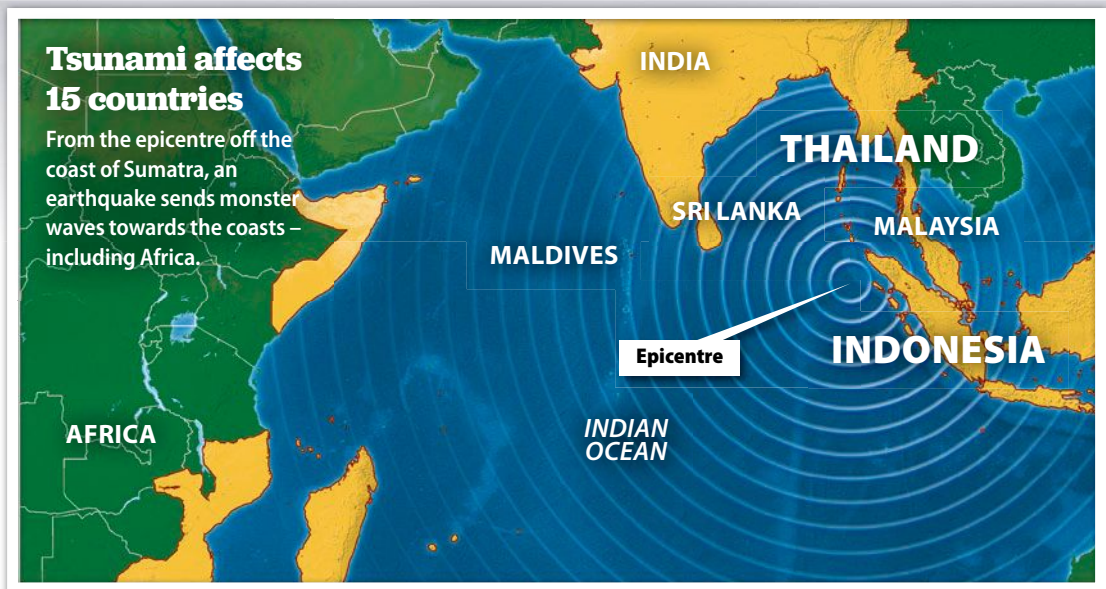
Tilly recognises this from a video she watched in a geography lesson back home in the south of England a few weeks before the holiday. Her class studied tsunamis and watched a film about a tsunami that hit Hawaii in 1946. Tilly recognises the danger signals – the fizzing ocean and the water which is suddenly sucked away from the beach. As the other people on the beach watch the exposed ocean floor in awe, small fish wriggling in the mud, Tilly tries to explain what she learned

about tectonic plates and undersea earthquakes to her parents. When the parents finally understand, they take action: The family helps hotel employees clear the beach of approximately 100 early risers in a few minutes. Tilly and her family run to the third floor of the hotel, only to witness a horrible sight. Like an ►



This dramatic photo shows the impact of a secondary wave. The people shown here have already survived the first – note the wet ground. No one in this photo was harmed.

BEHIND THE DISASTER



► express train, a towering wall of water is heading directly for the coast and the hotel.

ACCUMULATED TENSION CAUSES HAVOC

The word tsunami is Japanese and means “harbour wave”. The phenomenon most frequently occurs in the Pacific Ocean, but it may also develop elsewhere. Tsunamis are typically produced by undersea earthquakes, in which tectonic plates, i.e. huge, inflexible pieces of the Earth’s crust, collide.

That is exactly what happens on 26 December 2004 west of the Indonesian island of Sumatra. The Indian Plate forcefully subducts the Burma Plate at a depth of 30 km, making the ground tremble violently at a

magnitude of Richter 9. The earthquake is the worst in four decades, and the energy from the quake corresponds to the explosive force of 23,000 of the nuclear bombs which devastated the Japanese city of Hiroshima in 1945. In a few minutes, the ocean floor rises 10-20 m, and 1,200 km of Earth’s crust splits like a melon. Huge water masses are set in motion, producing monster waves that spread like rings in the water from the quake epicentre at a speed of 1,000 km/h.

AUTHORITIES GIVE UP WARNING

In cities hundreds of kilometres from the epicentre, people feel the ground tremble. In the big cities of Singapore and Kuala Lumpur, which feature some of the tallest structures in the world, skyscrapers begin to

Quake sets ocean in motion

When an earthquake rocks the ocean floor, it can set huge bodies of water in motion, converting them into monster waves near the coasts.

CLAUS LUNAU

1. Tension triggers quake

Tension builds between two tectonic plates. After a while, the tension is released in an earthquake.

Tension

INDIAN PLATE

BURMA PLATE

2. The ocean floor pushes the water

The ocean floor moves upwards, making the water move away from the epicentre at a speed of up to 1,000 km/h. The wave can hardly be seen in mid-ocean, but it may be hundreds of km wide.

The ocean floor sets the water in motion.

Released tension pushes the ocean floor upwards.



sway, and the same thing happens in Thailand's capital, Bangkok, more than 1,000 km away from the epicentre. There, the government discusses whether to warn the public about the danger of a tsunami. But experts estimate the risk to be very small, and so, the government remains silent. Nobody wishes to scare the population and the tens of thousands of tourists enjoying themselves in holiday resorts on the heavenly shores for no particular reason.

SENSORS CAN WARN OF HUGE WAVES

The countries bordering on the Pacific Ocean, which are most frequently hit by tsunamis have used a warning system, which allows the evacuation of coastal areas threatened by a tsunami in time.

The warning is based on sensors on the ocean floor registering changes in the water pressure indicating a passing tsunami. The resulting data is sent to a buoy on the surface of the ocean and on to a warning centre via satellite. Based on the data, experts can calculate, whether a tsunami is developing, how powerful it is, and in which direction it moves. If there is a risk of a tsunami, they will immediately issue a tsunami warning, allowing the people of the affected regions to leave the coast.

The first Pacific warning system was established in 1949, but in 2004, the nations bordering on the Indian Ocean do not have such a system. The countries are poor, and the system is extremely expensive to establish – one single buoy costs approximately \$200,000. Moreover, tsunamis rarely occur in the region. At times, when undersea earthquakes cause a tsunami close to the shore, a warning system will not help much, as the tsunami can reach the coast in a few minutes, so there is not much time from the warning until the monster wave hits.

FAILED WARNING ATTEMPT

Right after the earthquake, Baya Pranata, the on-duty geologist of the Indonesian Agency for Meteorology, Climatology, and Geophysics in Padang on the west coast of Sumatra, hears a strange tuk-tuk-tuk sound. He glances out of the window to see what is going on, only to realise that the sound comes from the agency's seismograph.

The sensitive measuring instrument is working overtime, indicating a huge earthquake – the worst in modern time. Instinctively, Baya Pranata fears that a tsunami may be developing, and he immediately calls the national earthquake centre in Jakarta to sound the alarm. It is Sunday morning, and nobody answers the phone. Pranata does not know what to do, and though he is very uncomfortable with the situation, he does not take any further action.

FROM RIPPLE TO TOWERING WALL OF WATER

When a tsunami roars towards the coast, the entire ocean is vibrating. In open sea, where the water is deep, the tsunami can hardly be registered, and it is typically only observed as a ripple on the ocean. But when the tsunami approaches the shore, and the water becomes more shallow, its speed is reduced to 30–40 km/h, and the wave energy that was previously distributed across a water depth of several kilometres is suddenly compressed. As a result, the water is forced upwards, rising into a 30-metre-high vertical wall of water colliding with the coast. Its power is massive, almost unthinkable. Often, but not always, the water will retreat from the coast, emptying bays, inlets and harbours, right before the ►

TSUNAMI

■ Quake magnitude:
Richter 9

■ Wave height:
10–30 metres

■ Wave velocity:
Up to 1,000 km/h.
Near land: 30 km/h.

3. The wave loses speed

As the body of water approaches the shore, it is slowed down to some 30–40 km/h by the higher ocean floor. The huge pressure will often suck the water away from the beach, adding to the wave.

Decreasing water depth
increases wave height.

4. The wave hits the shore

The water moves back towards the beach. A monster wave – up to 30 metres high – hits the shore with a force that can wash away entire cities.

The wave builds up
to extreme heights.

BEHIND THE DISASTER

The tsunami inflicts death and destruction on as much as 10 % of Earth's surface, making it one of the worst natural disasters ever in the world.



PHILIP A. MOON/US NAVY

► tsunami hits. Often one tsunami is not alone, rather a so-called wave train consisting of several waves catches up forcefully from behind, hitting the coast at intervals of between five minutes and one hour. A wave train typically consists of 2-5 monster waves, each commanding huge, devastating force.

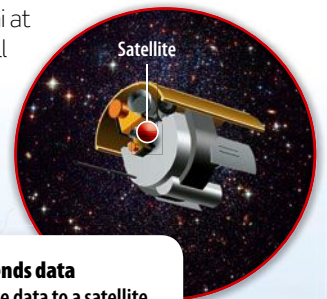
WAVES LEAVE NO SURVIVORS

After only 15 minutes, the tsunami hits the big city located in the closest proximity of the quake epicentre: Banda Aceh, the capital of the province of Aceh, Northern Sumatra, Indonesia.

The some 320,000 citizens woke up to a beautiful day, and as the cocks crow, and the Sun rises in the

sky, the streets are busy with activity: Children are playing ball, cars are honking, and adults are tending their fishing nets. Not a single soul knows what is about to happen.

Around eight o'clock, the huge body of water of the first tsunami hits Banda Aceh. At a furious speed, the wall of water floods the low-lying city, over-powering everybody and everything. Those who experience the tsunami at close range do not live to tell others about its power, and they never realise that the wave is not the only one – it is accompanied by



2. Satellite sends data

The buoy sends the data to a satellite that is in contact with warning centres all over the world. Experts use the data to calculate the risk of a tsunami and sound the alarm, if necessary.

Sensitive sensors reveal tsunami

After the tsunami, a new warning system was installed in the Indian Ocean equivalent to the one that has warned about possible tsunamis in the Pacific for decades. The system consists of sensors on the ocean floor that send data to centres throughout the world via satellite.

CLAUS LUNAU

1. Sensor detects wave

A sensitive pressure gauge – a tsunameter – sits on the ocean floor. The instrument can register pressure changes caused by a passing tsunami. The measurements are sent to a buoy at the surface of the ocean.

Vibration

Signal

Buoy

Pressure gauge



another two 30-m-high, devastating waves. Humans, animals, homes, mosques, cars, boats, bridges, roads, trees, signs, electricity poles: everything is torn up, crushed, and consumed by the foaming water, which hits with immense power. The citizens who miraculously survive the first tsunami fight a desperate battle to resist waves number two and three, but there is only one winner: the tsunami.

A few hours later, when the water retreats, Banda Aceh is totally devastated. The busy city is nothing but dead bodies, rubble, and mud. A 15-m-long, iron-hulled fishing boat has landed 5 km from the coast, bearing witness of the violent forces at play. Up to 6 km from the seaside, people have drowned, parents have lost their children, and children have lost brothers, sisters, and parents. An entire city has been wiped out.

FOREST CAN REDUCE WAVE POWER

Tsunamis hit the hardest in low-lying coastal areas such as Banda Aceh, where the mangrove has been cut down. The mangrove is a dense, swampy forest functioning as a natural buffer between the ocean and the land, and it can reduce the effect of a tsunami by up to 90 %.

Between 1980 and 2000, some 25 % of all mangrove forests along the coasts of the Indian Ocean were cleared in favour of structures, ports, and fish farms. In the Aceh Province, lack of mangrove is the main reason that the disaster is so comprehensive. If it had still been there, it could have reduced the effect of the tsunami considerably, before the water hit the shore. The mangrove would also have functioned as a filter, capturing loose objects, before they were flung onto the shore with lethal consequences.

WATER MASSES CAPTURE TRAIN PASSENGERS

At the southern point of Sri Lanka, everything is still quiet on the Ocean Queen passenger train, which is approaching the port city of Galle. Due to Christmas and a Buddhist full moon festival, the eight cars of the train are full of happy people about to enjoy their holidays. Hundreds of the approximately 1,800 passengers are clinging to the outside of the train or sitting on the roof, from where there is an outstanding view: The railway runs along the picturesque coast line, and when the train stops at the village of Peraliya at 9.30, the passengers enjoy the sight of swaying palm trees and the bluish green ocean.

Suddenly, scared screams can be heard. A group of women and children come running from the beach towards the train, as if they were followed by the Devil himself. The screams are immediately drowned by the roar of the ocean. A huge wave hits the train, filling the cars with water. Panic spreads in the train, as the passengers gasp for breath, and mothers desperately

try to get their children out through windows and doors, as another, almost 10-metre-high wave hits, lifting the Ocean Queen off the rails, knocking it over, and pushing it into the nearby jungle, as if it were a toy.

It is the worst train disaster in history. Only a few passengers manage to get out of the withered wreck, whereas the rest – at least 1,700 people – drown in the cars or are crushed to death

WAVES TRAVEL VAST DISTANCE

The devastating forces can also reach Sri Lanka, as tsunamis do not lose much energy on their way through the ocean. They can cause havoc on shores located thousands of kilometres from the earthquake epicentre, and the tsunami of December 2004 even claims lives in Africa, 8,000 km away.

The repercussions of the monster waves can be felt throughout most of the world and are registered in Arctic waters and on both the west and east coasts of the US. The earthquake itself can be felt anywhere on Earth – it is so extreme that it makes the entire planet vibrate, causing the underground throughout the world to rise by an average of 10 mm. In the course of half an hour, the vibrations reach Denmark in the Northern Hemisphere, 10,000 km from the epicentre of the earthquake. The violent tremor makes the Danish underground rise approximately 4 mm for a period of 20 seconds, after which it falls back into place. ►



Karl Nilsson, a Swedish survivor, gave the tragedy a European face when he lost his entire family. He was eventually reunited with his grandparents.

AP/POLETO

BEHIND THE DISASTER

Before the tsunami hits on 26 December 2004, everything is peaceful on the coasts bordering the Indian Ocean.

BEFORE



When the first, limited quantities of water have hit the coast, the water recedes from the beach.

THE WATER RECEDES



Huge, whirling volumes of water hit the coasts, consuming homes, people, and roads several km from the shore.

FLOODING



DIGITALGLOBE

► TOURIST PARADISE WASHED AWAY

Many Europeans feel the consequences of the quake on their own skin, so to speak. Some European tourists are spending their Christmas holidays on the Thai island of Koh Phi Phi, which is particularly known as a bountiful land of picturesque palm beaches and a turquoise ocean.

Seen from above, the island resembles an H with two tall, rocky islands linked by a some 1-km-long and a few hundred-metre-wide isthmus, where the tourists hang out. In a bungalow on the isthmus, British diver Steve Hunter is asleep. At 9.45, he is awakened by a sound that reminds him of thunder and splashing water. Confused, he tries to locate the sound, as a cascade of water comes through the door, which is shattered. The huge body of water leaves Steve stuck against the wall, as the water level rises around him. He decides to breathe a mouthful of air and dive towards a hole in the wall, and he is immediately captured by the turbulent water and swept outside. He gets back on his feet and flees up on a hill, blood flowing from a deep wound in his foot. He limps into a cabin, which is already full of shocked people. In the distance, the terrified group can hear desperate screams.

Approximately 14-m-high waves have struck and flooded the isthmus from both sides. The entire area has been devastated, and dead and wounded people are scattered everywhere among the shattered structures.

TSUNAMI KILLS 250,000 PEOPLE

Apart from Koh Phi Phi, the Thai tourist destinations of Phuket and Khao Lak are badly affected by the tsunami, and some 50 % of the 11,000 people killed in Thailand are tourists. All in all, the disaster claims at least 230,000 lives. The Aceh Province and the rest of Northern Sumatra are particularly badly affected.

Indonesia and Sri Lanka are the most badly affected with 125,000 and 31,000 dead, respectively. The total death toll is just under 250,000.



The disaster develops day by day, hour by hour

Sunday 26 December 2004:

7.59

A massive, Richter 9 earthquake hits the ocean floor off the northwestern shore of Sumatra. The quake shakes structures far from the epicentre such as in Bangkok, the capital of Thailand, 1,260 km away.

8.15

Huge waves hit the Indonesian island of Sumatra, where cities, big and small, are washed away by up to 30-m-high waves. The Indian Nicobar Islands and the Andaman Islands in the Bay of Bengal are also affected.

9.30

Southern India, Sri Lanka, and Thailand are hit by the huge volumes of water. Sri Lanka and Indonesia are most badly affected by the wave.

11.00

The monster wave hits the Maldives, which are flooded by the tsunami, that continues to the shores of East Africa and even Port Elizabeth on the south coast of South Africa. There, a three-metre-high wave hits after a journey of approximately 12 hours or 8,000 km.

After the disaster

Monday 27 December: A huge rescue operation is initiated, and the UN sends in the first emergency aid team. Initially, the number of casualties is estimated to be 27,000.

Tuesday 28 December: In the late afternoon, the AFP news agency announces that 55,000+ people are confirmed to have been killed.

Wednesday 29 December: The number of casualties has reached 77,000, and the people of the affected countries are striving to bury the dead, before epidemics break out.

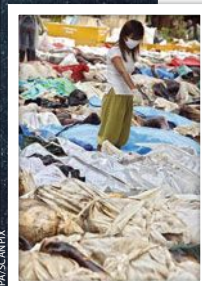
Thursday 30 December: In the morning, the death toll has reached 82,847, but during the day, the number increases drastically, reaching 114,000. UN Secretary General Kofi Annan characterises the tsunami as "an unprecedented global disaster".

Friday 31 December: The death toll reaches 124,000 and is still rising. The disaster throws a wet blanket over New Year celebrations throughout the world, and several countries observe a minute's silence.

Saturday 1 January 2005: Relief is beginning to reach the most badly affected regions, which have been isolated after the disaster, including Banda Aceh in northern Sumatra, Indonesia. According to new UN estimates, the death toll will exceed 150,000.

Wednesday 5 January 2005: The UN estimates that apart from the many casualties, up to 1.3 million people have lost their homes in Indonesia and Sri Lanka, the two most badly affected countries.

Wednesday 19 January 2005: Media throughout the world estimate the total death toll to be some 230,000.



The disaster brings on the most extensive rescue mission in history. From all over the world, emergency aid flows to the affected countries along with large teams of dentists and forensic pathologists, who are to help the local authorities identify the dead. After the tsunami, several countries start to replant their mangrove forests, so the coastal areas will be better protected against a new disaster, and moreover, the UN and the countries bordering on the Indian Ocean decide to establish a warning system like the one in the Pacific region.

For the first time, satellite images are used to map out the extent of the disaster. They also help authorities and organisations coordinate emergency aid, which is important, as large regions have been cut off from the outside world due to the disaster.

COMING TO TERMS WITH TRAGEDY

As the international community is still struggling to grasp the full extent of the tragedy during the days following the tsunami, the media are overflowing with horrifying reports from the affected regions, but they also tell positive stories with happy endings: of people who have miraculously survived. Infants are found alive after having sailed about on mattresses, and children and adults are found in palm trees and on hilltops, where they have taken refuge. Reporters also characterize Tilly Smith as a hero. Because she paid attention to what her school teacher said, some 100 tourists on a beach in Phuket, Thailand, managed to flee and save their lives – a small bright spot in the abysmal darkness left by the disaster. **SCI**

This article is based on eyewitness accounts, books, documentaries, UN reports, and a long series of newspaper articles.



EVERY DAY, WE ADD OVER

16,438,356,000,000 MEGABYTES

TO A HUGE OCEAN OF DATA. MATHEMATICAL SUPER FORMULAS ALLOW US TO MAKE SOME SENSE OF THE NUMBERS AND FIND OUT WHAT WE DIDN'T KNOW WE NEEDED, HOW MONEY WILL MOVE, OR WHERE THE NEXT EPIDEMICS WILL BREAK OUT.

CLAUS LINAU

By Lasse Hedegaard Poulsen

NEW METHODS ORGANISE CHAOTIC DATA

Big data is the ability to make sense of data sets and types that used to be too extensive, versatile, or variable to analyse. Previously, it was only possible to seek information in traditional, structured databases such as spreadsheets. But by using sophisticated mathematical computer code, also known as algorithms, it is now also possible to retrieve information from so-called unstructured data such as:

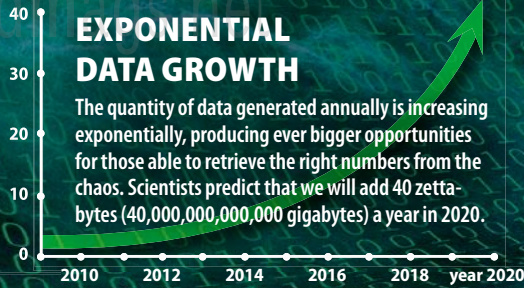
- e-mails
- conversation
- sound files
- photos
- videos

BIG DATA

Zettabytes per year

EXPONENTIAL DATA GROWTH

The quantity of data generated annually is increasing exponentially, producing ever bigger opportunities for those able to retrieve the right numbers from the chaos. Scientists predict that we will add 40 zettabytes (40,000,000,000,000 gigabytes) a year in 2020.



1,000 MEGABYTES = 1 GB

1,000 GIGABYTES = 1 TB

1,000 TERABYTES = 1 PB

1,000 PETABYTES = 1 EB

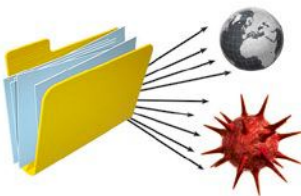
1,000 EXABYTES = 1 ZB

EBOLA BREAKOUT WAS PREDICTED BY BIG DATA

Data analyses of blogs, news sites, and social media predicted the 2014 Ebola epidemics.

The computer codes of the HealthMaps website browse thousands of websites, health reports, blogs, and social media posts every day to find content that can identify new disease outbreaks throughout the world. The potential disease breakouts that the system finds will subsequently automatically be visualised on a constantly updated map. Analyses of the massive quantities of data predicted the 2014 Ebola outbreak in Western Africa nine days prior to the official WHO warnings.

FOUR STAGES OF DISEASE MONITORING



1. COLLECTION

Disease-related data is collected from public data sources ranging from news sites, blogs, and for to social media.



2. CATEGORIZATION

The finds are categorised by the type of disease and the location of the outbreak.



3. GROUPING

Subsequently, repeats are deleted, leaving only the finds that are either brand new or related to current events.

4. FILTRATION

Finally, the finds are filtered according to relevance and given a warning stamp— from “Nothing to report” to “Global alert”.

HealthMap categorises disease outbreaks.
HEALTHMAP



HEALTH

The 2014 Ebola outbreak was predicted thanks to real time analyses of blogs, etc.

DOMINIQUE FAGET/AFP/SCANPIX

79.9 million DVDs can be filled with the information we generate every hour.

1,310,000,000 active Facebook users exist – equal to one fifth of the global population.

901,560 dollars is the average cost of a data centre full of servers going offline. Such centres suffer a total breakdown once a year on average.

900,000 Google servers exist throughout the world to facilitate searches, Gmail, and more.

1 BILLION people watch at least one YouTube video per month.

450,000 servers cater for Amazon customers.

2.4 BILLION people have Internet access.

Every time you visit a website, type a search word into Google, watch a film on Netflix, or make a post on Facebook, you leave a digital footprint. And every single footprint is registered in an ever growing data bank, which is also filled with data and information deriving from everything from weather stations to production plants.

All contribute to producing the huge quantities of data flowing into thousands of servers at data centres throughout the world every single second of the day. The sheer amount of data is so large, increases so fast, and is so complicated to handle that we now talk about "big data".

IT and computer scientists long ago predicted the huge potential of big data, and several companies and authorities are already trying to utilise the information.

Big data is used for the development of TV series. The Netflix streaming service based the development of the prize-winning House of Cards series on big data, the data helps the police predict crimes, and the Danish wind turbine

Amazon tempts you

Webstores such as Amazon have used big data analyses of the site's visitor data for years to produce customised offers meant to tempt individual customers.

maker Vestas finds the best locations for its wind turbines based on huge quantities of weather data.

WE ARE FLOODED BY DATA

There is no clear-cut definition of the concept of big data, but the basics of the phenomenon can roughly be boiled down to three elements known as the three Vs: Volume, Variety, and Velocity.

First and foremost, big data is defined by volumes and scale. In 2012, we produced 2.8 zettabytes of data, corresponding to the content of 700+ billion DVDs.

But big data is also about the variety of all the different types of data that are registered. Traditional types of data such as the number of text messages sent, articles

Banks adjust cash holdings

In Singapore, banks use real time analyses of ATM data to plan the best time to feed the machines new cash to meet expected daily demand.

bought at the supermarket, and bank transactions made can be sorted out and arranged systematically, so they are easy to handle and search through. But that is not the case with so-called unstructured data, which includes video, Facebook messages, e-mail correspondence, sound files, and almost anything else you can think of.

Such information cannot be stored in traditional databases or spreadsheets, as they are not characterised by any solid structure or organisation.

For instance, a photo may include many different types of information which the human brain can decode and interpret.

But in order for a computer to understand this type of information, special analysis tools are required such as facial and optical character recognition software.

The final element defining big data is the great velocity at which data are produced. ►

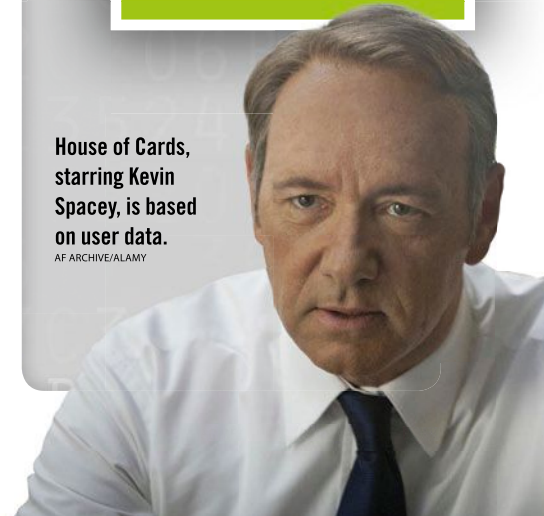
NETFLIX USES SEARCH WORDS TO MAKE HIT SERIES

When the Netflix streaming service invests millions of dollars in a new TV series, its 44 million users have great influence, although they are not asked directly. Netflix continuously records the behaviour of the users: the films they watch, the genres they prefer, the titles they search for, and the actors and directors that attract the most viewers. Subsequently, data analyses give Netflix an idea of the ingredients required for a film or series to become a success. This method was employed, before Netflix chose to spend US\$100 million on the political drama series House of Cards, starring Kevin Spacey. The investment paid off, as House of Cards turned out to be a major hit, helping Netflix secure a 2013 turnover of more than US\$4.37 billion.

TV SERIES

House of Cards, starring Kevin Spacey, is based on user data.

AF ARCHIVE/ALAMY



BIG DATA

All our data is stored in data centres and server farms, which have grown huge to meet demand. Right now, the world's biggest data centre is built in Langfang, China. The centre will cover an area of 585,000 m².

EVERY MINUTE...

Apple App Store users **DOWNLOAD**

48,000 apps

Amazon **SELLS** products worth \$96,000

2.4 million e-mails are **SENT** throughout the world

POLICE WORK

CRIMINALS ARE FOUGHT WITH BIG DATA

Using earthquake prediction methods, the Los Angeles police can find out where the next crime will likely take place.

In Los Angeles, the police has embraced data tools, combining information from 13 million criminal cases with earthquake mapping methods. When an earthquake strikes, the likelihood of aftershocks in the area increases. The same is true for crime.

If a car is stolen in one particular area, the risk of more car theft increases. So, every police officer is assigned to areas of 50 m², which must be patrolled extra carefully. The method has caused the number of thefts fall by 33 % in some parts of the city.

HEAT MAPS REVEAL RISK OF BURGLARY

When mathematical earthquake analysis formulas are fed criminal databases, etc., the police produces so-called heat maps. The maps allow the police to predict where the risk of particular types of crime is particularly high, so officers can step up patrolling in those areas.

PREDPOL



By analysing data from the past 80 years of criminal cases, the police can predict where criminals will strike next.

KEVORK DJANSEZIAN/GETTY IMAGES

► Scientists estimate that by 2020, we will produce 40 zettabytes – or the contents of more than 1012 DVDs.

Apart from the fact that data quantities are growing very fast, the speed often also means that the data is outdated very soon, as new, relevant data is constantly flowing in. Each time we like content on Facebook, we send bits off into the constantly changing flow of data.

Previously, it may have been sufficient to analyse one's data once a week, but now, the massive data flow requires that the information be sorted out and analysed right away, if possible.

BIG DATA COMPILES INFORMATION

When the three Vs of big data were described for the very first time in 2001, the database information "lived" in separate, closed silos. A database involving the number of articles sold in a shop, could not suddenly be fed statistics concerning the local soccer team. That would ruin the purpose of the database and its representation of how many articles the shop had sold.

Punctual public transport

Faster and better real time analyses of traffic will improve the service and help bus and train companies solve problems faster, so delays and queues can be avoided.

Skype users for a total of **TALK**
23,300
hours

Facebook users
SHARE
2,460,000
pieces of content

Instagram users
POST
216,000
new photos

Tinder users
SWIPE
potential partners and decide for or against
416,667 times

Twitter users
WRITE
277,000 tweets

Google **RECEIVES**
4,000,000
searches

72
hours of new
YouTube videos
are **UPLOADED**

Football tactics are predicted

In the future, coaches of sports such as American football can use big data analyses of historical match data as a tool to predict the other team's next tactic move in real time.

But as regards big data, this is a narrow-minded way of thinking. Instead, the approach to data must be more observing. If the answer is not found in one database, it no longer automatically means that the information cannot be found elsewhere. Consequently, big data is to be understood as a new method and a tool to be used for bringing together a high number of information sources and helping create new knowledge and contexts involving anything from spread-sheets and Facebook likes to videos.

WATSON DIAGNOSES CANCER

Although our computer power is constantly improving, doubling every 18 months, that is not the main reason why

companies and authorities can use big data to a greater extent. The answer is more likely to be found in the improved statistics and analytical software that computers are fed. Specially coded mathematical formulas can browse through massive data quantities and solve a problem faster and cheaper than raw computer power.

This was proved by an American professor, Gary King, when one of his colleagues had a problem, which required the Harvard University in Massachusetts to buy a supercomputer worth millions. In just two hours, Gary King developed a mathematical algorithm for an ordinary laptop computer, which could solve his colleague's problem.

New types of tools are constantly emerging that can help us solve highly tangible tasks. This fact is utilized by IBM's Watson supercomputer, which gained world fame in 2011, when it out-competed two Jeopardy winners in a live television show. Today, Watson uses big data algorithms for

purposes such as servicing customers in the chat systems of webstores and help financiers make the right decisions.

In the near future, Watson may also assist doctors, when patients are screened for cancer. By feeding Watson 600,000 medical research results, two million pages of medical journals, and 1.5 million

Big data help doctors

Analyses of patient data and big medical data sets will soon be ready for use by doctors as an auxiliary tool for diagnosing cancer and other diseases.

medical records, the supercomputer acquired knowledge that could never be matched by any doctor.

In an experiment, Watson diagnosed patients with lung cancer correctly in 90 % of the cases, as compared to a 50 % rate of "ordinary" doctors.

So, big data are not only able to place wind turbines in the right places and predict crime – it can also save lives. **SCI**

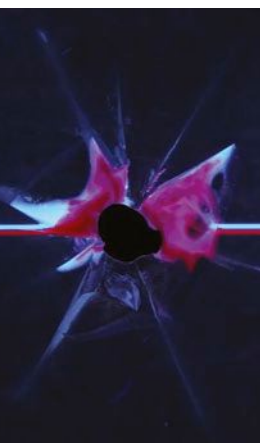
WEATHER DATA PLACE WIND TURBINES IN THE MOST WINDY PLACES

Combining massive processing power with data from 35,000 meteorological weather stations and sensor data from more than 43,000 existing wind turbines, Danish wind turbine maker Vestas has produced a huge

world map of global wind patterns. Vestas utilises the map to predict future wind conditions – and consequently the output of a wind turbine – in specific areas of down to 10 m².

ENERGY

Accurate weather data can determine the very best location of Vestas' wind turbines.



SCREENSHOT / UNIVERSITY OF ILLINOIS

Healing Plastic

A new plastic material with an integrated repair kit can mend damage to itself the size of bullet holes. The plastic is particularly useful in places, where it is difficult to make repairs, such as in space and in connection with artificial bones implanted into the body.

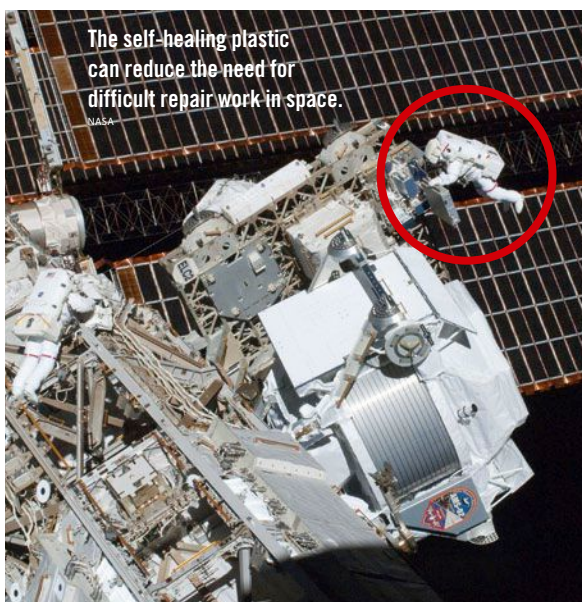
By Rolf Haugaard Nielsen

The large cloud of wreckage from a Chinese space mission rushes through space, approaching a Russian satellite. The space junk is heading directly for the satellite, but misses it by a few metres – except from a small piece of space junk, which slams into the rear side of the satellite, producing a hole measuring several centimetres behind the solar panels protecting the electronics for the satellite's power. In spite of the severe damage, there is no reason for the mission control to panic. The wall is made of a new material which will repair the hole in a few hours, using sturdy plastic.

The scenario is still a future one, but scientists from the US University of Illinois have developed a prototype of a self-healing plastic material, with which they have managed to repair a hole of approximately one centimetre in lab experiments.

PLASTIC SETS NEW WORLD RECORD

The experiments have beaten the existing world record concerning the size of holes and cracks to be repaired by regenerating plastic by 100 times. And contrary to previous solutions, the technology works without the need for temperature changes or electric impulses to start the process.



The US scientists were inspired by human physiology – the way in which blood flows through the body – oxidised blood flows through the arteries, and oxygen-poor blood flows through the veins. Similarly, scientists have built two parallel capillaries in the plastic, containing two different liquids.

The capillaries are made by building fibres into unprocessed plastic. When the plastic is heated, the fibres evaporate, leaving only empty capillaries before the plastic hardens. The capillaries are filled with two liquids, and as long as the plastic is intact, the liquids are separated and inactive. If the plastic breaks, the liquids flow from the parallel capillaries into the hole, where they mix and start to produce a

non-spilling, thick gel. In the course of a few minutes, the gel fills out the entire hole and the surrounding cracks, but it is not sturdy enough to tolerate the same loads as the original material.

So, other chemical reactions convert the soft material into hardened plastic in a few hours' time – a material which is almost as strong as the original.

BROKEN ARTIFICIAL LIMB - NO PROBLEM

So far, the method has been tested on two types of industrial plastic: thermosetting plastic such as epoxy and thermoplastic, including both soft plastic for plastic bags, etc, hard plastic for water pipes and toys, and plexiglass. The experiments have shown that the method can also be employed with plastic used in cars and planes, and it can make implants highly durable. If an artificial hip socket develops a large crack, the patient will not need new surgery, as the prosthesis will heal itself.

But before reaching this point, a considerable development effort remains. So far, the plastic only includes two capillaries, but for holes anywhere in the material to be able to repair themselves, many, closely packed capillaries need to exist.

Repeated damage to the same place must also be able to repair itself – such as by a liquid deposit in the plastic filling up the capillaries after each repair.

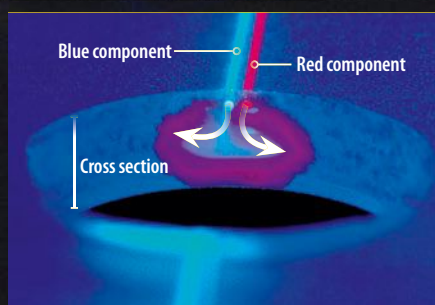
And according to scientists, space missions need soon no longer fear damage caused by the growing amounts of junk flying about in space. **SCI**

The gel can repair cartridge holes measuring several cm.

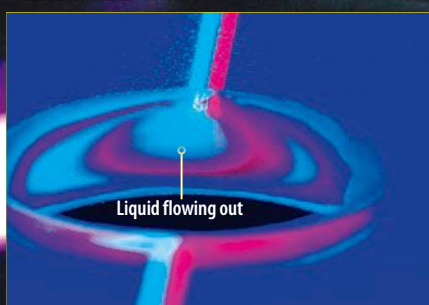
BRETT KRIULL, DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING, UIUC

GEL GLUES HOLE TOGETHER

The self-healing plastic functions as a glue with two components. When the plastic is damaged, two liquids mix, producing a solid, gel-like material.



1 Two capillaries containing blue and red liquid respectively are integrated in the plastic, and together, they can repair the hole. When a hole in the plastic penetrates the capillaries, the liquids flow out to fill the hole.



2 The two liquids mix at the outer margins of the hole. The liquids contain substances which trigger the production of a solid material when the two liquids mix, and accelerate the process.



3 The material fills up the hole in a few minutes. It is solid and thick like gel, and so cannot spill from the hole, like an ordinary liquid (such as glue) would.

4 Within three hours, the soft gel has been converted into sturdy plastic. The gel contains the building blocks of long, tangled polymer chains resembling spaghetti on a plate.

NATHAN BAJANDAS, BECKMAN INSTITUTE, UIUC

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MA/SCI34

The film "Exodus" is the biblical story of Moses, who leads the Israelites out of Egypt. Moses, played by Christian Bale, gets help from God, who inflicts 10 plagues upon Egypt to persuade Pharaoh to free the Israelite slaves.



PLAGUE
1

THE BIBLE'S 10 PLAGUES WERE NATURAL PHENOMENA

In the Bible, God punishes Egypt's Pharaoh by converting rivers into blood, spreading darkness, and having huge hailstones fall from the sky. If the plagues were real, supernatural powers need not have caused them. According to scientists, the 10 plagues may be explained by algae, volcanic eruptions, climate change, and more...

By Peter Eberhardt

EGYPTIAN WATER TURNS TO BLOOD

God's first plague struck as he changed all water in the country into blood. Today, it is a well-known fact that some rivers may become temporarily red. Climatologists have documented huge climate change during the period. The warmer climate may have dried out the Nile, converting the river into a slow-flowing, muddy, highly nutritious stream, in which algae thrived. So, the climate change could have caused increased algae growth. *Pfiesteria* algae give off a red pigment.

PLAGUES WERE PUNISHMENT

Egypt's Pharaoh is a ruthless ruler. The region is thriving – not least due to Israelite slaves. As a baby, Moses is adopted by Pharaoh's daughter, but he is forced to flee after killing an Egyptian, who mistreats an Israelite. For 40+ years, Moses gets by as a desert shepherd, until he meets God in the form of a burning bush. God appoints Moses to lead the Israelites out of Egypt and back to the promised land of Canaan. Moses pays Pharaoh a visit to make him free the slaves. When Pharaoh refuses, God inflicts the 10 plagues upon Egypt.



THEORIES:
Warmer climate dried out rivers: a perfect environment for algae, that contaminated the water with red secretion.

CONCLUSION:
A combination of dry rivers and more algae probably coloured Egypt's rivers and lakes blood-red.



PLAGUE 2

MILLIONS OF FROGS INVADE THE COUNTRY

God makes hordes of frogs invade Egypt. Frog development depends on a particular hormone. When frogs experience imminent danger such as their stream being taken over by oxygen-consuming algae, they can speed up the development from tadpole into frog. If the rivers had dried out or become contaminated by algae, a “baby boom” probably took place, during which thousands of frogs jumped out of the contaminated water and into the houses of people, looking for food.



THEORIES:

More algae mean fewer fish and fewer enemies of tadpoles, which can also speed up their development into adults.



CONCLUSION:

The tadpoles probably both had fewer enemies and sped up their development into adult frogs.



PLAGUE 3

LICE ATTACK MEN AND ANIMALS

Egyptians and their animals are attacked by lice - or at least that is how the plague is described in modern Bible translations. But according to scientists, it is debatable whether the plague was really caused by lice. First of all, the original Hebrew word for louse is used for more than 100 different insect species. Secondly, human lice do not live on animals. Instead, scientists suspect that itch mites, ticks, and biting midges caused havoc.



THEORIES:

Scientists believe that the plague was caused by ticks, itch mites, or biting midges.



CONCLUSION:

Biting midges attack both humans and animals, so they are the most probable candidates.



PLAGUE 4

SWARMS OF FLIES PESTER EVERYTHING

God sends huge swarms of flies upon the Egyptians. Scientists have suspected several species, but by studying behaviour such as swarms and bites, scientists have ruled out a number of species and may have found the culprit.



THEORIES:

The bites of tsetse flies and stable flies leave open wounds, so they have both been mentioned as candidates.



CONCLUSION:

The nuisance was probably caused by the stable fly, which, unlike the tsetse fly, lives in dry areas.



PLAGUE 5

PLAGUE KILLS LIVESTOCK

Next, huge swarms of insects infect livestock with diseases. According to the Bible, livestock belonging to Egyptians get the plague, whereas the Israelites' animals do not. However, there may be a natural explanation of the fact that only Egyptian livestock get sick. According to scientists, the disease carrier could have been a biting midge of the *Culicoides* genus. The midge rarely leaves its territory, so it would not fly to the areas, in which the Israelites lived with their own livestock.

THEORIES:

Scientists suspect that both African horse sickness and the bluetongue virus could have caused the fifth plague.

CONCLUSION:

The plague also affected cattle and goats, and African horse sickness does not, so bluetongue killed the animals.



PLAGUE 6

BOILS BREAK OUT ON PEOPLE'S SKIN

Even after five plagues, Pharaoh still refuses to let the Israelites go, so God sends boils. According to scientists, this plague has to do with the swarms of flies which had already invaded Egypt, as the Bible says. Flies can transmit bacteria and diseases, which cause boils.

THEORIES:

Both anthrax and the *Burkholderia mallei* bacterium cause symptoms like the ones described above.

CONCLUSION:

Burkholderia mallei infects through the air, by body contact, or via insects, and the bacterium attacks both humans and animals. Hence, the boils were probably caused by the bacterium.



PLAGUE 7

HUGE HAIL RUINS HARVEST

After having been invaded by hordes of frogs and affected by different diseases, Egypt becomes the target of violent hailstorms, which spoil the country's crops, smashing them with ice.

ONLY ONE PLAUSIBLE THEORY/CONCLUSION:

Hailstorms occur regularly in most regions of the world – and can form enormous hailstones which devastate homes and kill humans and animals.





PLAGUE 8

LOCUSTS EAT EVERYTHING

Once the hailstorm is over, God sends a huge swarm of locusts to pester Egypt. The swarm is so huge that it covers the sky, and the last die-hard crops are consumed. Like in Central Australia.

ONLY ONE PLAUSIBLE THEORY/CONCLUSION:

Huge swarms involving billions of locusts are not rare in Northern Africa. The most likely culprit is the desert locust.



PLAGUE 9

DARKNESS REIGNS FOR DAYS

God punishes the Egyptians by having darkness fall on the country for three days. Three theories are plausible: The huge swarms of locusts may have produced an impression of darkness during the day, sandstorms could have blocked out the light, or an ash cloud from a volcanic eruption may have blacked out the country. The latter theory is supported by the discovery of ash believed to derive from a huge volcanic eruption.

THEORIES:

A sandstorm, an ash cloud, or a locust swarm could have blacked out Egypt, according to scientists.

CONCLUSION:

Scientists are inclined to believe that ash from a volcanic eruption on Santorini covered Egypt in darkness.



PLAGUE 10

DEATH OF THE FIRST-BORN

God inflicts his last plague upon the Egyptians: Their first-born children must die. According to one theory, the grain was infected by a fungus that made children critically ill. In Ancient Egypt, the older children ate first, which may explain that particularly first-born sons were affected. According to other scientists, more than 10 months of suffering the effects of the previous plagues such as famine and diseases simply made many Egyptian children die.

THEORIES:

The high child mortality rate was due to disease-causing food or to the effects of the other plagues.

CONCLUSION:

The indications are that the cocktail of the previous 9 plagues made the infant and child mortality rate soar.

How the fastest car ever could **NEED FOR S**

The Bloodhound SSC's three engines make the car the fastest in the world. It is aiming for a 1,600 km/h world land speed record.

By Jens Tralolt

Back in 1899, Camille Jenatzy of Belgium was the first to make a car, the electric *Jamais Contente*, travel faster than 100 km/h. But he would hardly have believed his eyes, if – some 100 years later – he had witnessed RAF fighter pilot Andy Green's record breaking ride in 1997, when he took his Thrust SCC vehicle to a super-sonic speed of approximately 1,300

km/h. In the course of those 100 years, everything from steam to jet engines have been employed to set new speed records, and Andy Green is now about to enter yet another engine type into the race. In 2016, the British Bloodhound SSC project aims to use a rocket to smash the record by more than 300 km/h to 1,000 miles per hour or more than 1,600 km/h.

ROCKET CAR INSPIRED BY FIGHTING PLANE

To make the car strong enough for the record speed of 1,600+ km/h, parts of the engine system and the windscreen material were copied from a fighter jet.

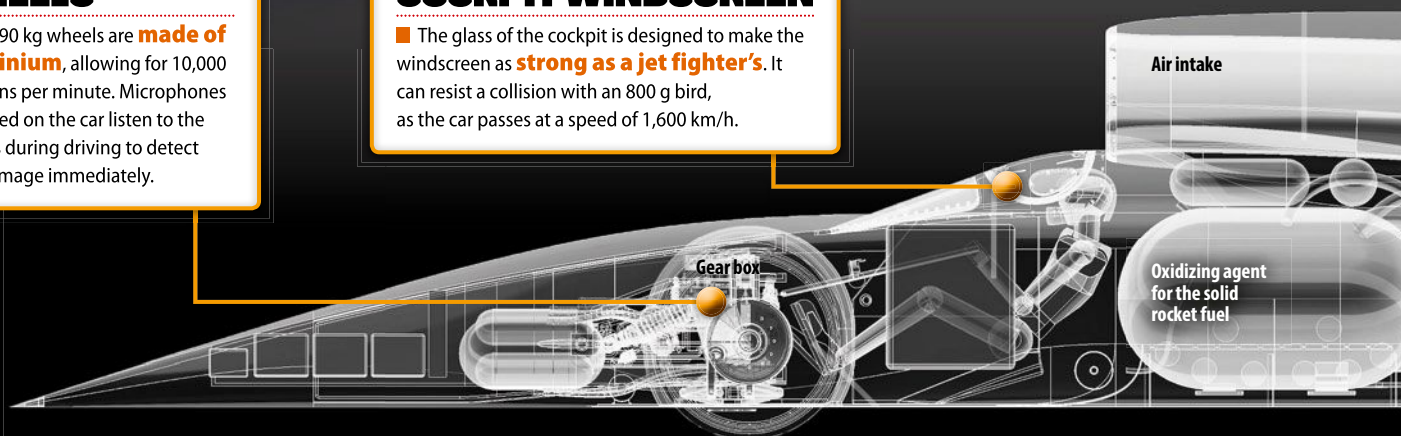
BLOODHOUND SSC/SHUTTERSTOCK

WHEELS

■ The 90 kg wheels are **made of aluminium**, allowing for 10,000 rotations per minute. Microphones mounted on the car listen to the wheels during driving to detect any damage immediately.

COCKPIT WINDSCREEN

■ The glass of the cockpit is designed to make the windscreen as **strong as a jet fighter's**. It can resist a collision with an 800 g bird, as the car passes at a speed of 1,600 km/h.



Length: 13.47 m

satisfy our **PEED**

NEW ENGINE INCREASES SPEED

The Bloodhound project is so ambitious that even two jet engines like the ones powering the existing record holder, the Thrust SSC, will not be sufficient, considering the massive air resistance. Improving the existing record by 30 % requires a power increase of much more than 30 %. With 25

hp and a top speed of some 100 km/h, a Citroën 2CV would require much more than 50 hp to be able to drive twice as fast. The engine power required increases exponentially with speed, so a speed of 200 km/h would require an engine of at least 120 hp.

Aiming for a top speed of 1,600 km/h, the Bloodhound SSC differs from other record-breaking car concepts by having both a jet engine and a special hybrid rocket engine. The jet engine is a big Rolls-Royce Eurojet EJ200 turbofan from the Eurofighter Typhoon jet fighter. The

4-m-long engine weighs less than 1,000 kg, but produces a force of 10 times its own weight - 90 kilonewtons (one newton is the force needed to accelerate 1 kg of mass at the rate of 1 m/s²).

One of the major challenges of this type of engine is that its control system has been adjusted for an aircraft and is used to being in constant dialogue with the aircraft. Now, the system must be ►

BRAKES

■ Air brakes, drag parachutes, and wheel brakes will stop the car before it runs out of track. The three braking systems will also make sure that the car **stops so fast** that it can complete two runs in one hour, as required to set a valid record.

JET ENGINE

■ A big Rolls-Royce turbofan engine from a Eurofighter Typhoon will boost the car up to 500 km/h.

ROCKET ENGINE

■ A hybrid rocket engine with both **solid and liquid fuel** will accelerate the car from 500 km/h to the top speed of 1,600 km/h. Along with the jet engine, it produces around 135,000 hp.

Height: 3.57 m



STEFAN MACHURAN/BLOODHOUND SSC

When the rocket engine of the Bloodhound SSC is ignited, it provides a force of 123 kN.

► reprogrammed for speeds of 1,500+ km/h at ground level and a completely different type of vehicle. If the motor control gets confused, the system could enter into safety mode, suddenly reducing the force and speed considerably.

The engine air intake constitutes yet another challenge. The Bloodhound team must make sure that the air intake does not become turbulent when the car breaks the sound barrier, as this could disturb the engine air intake and produce explosions and destructive vibration.

ROCKET SPEEDS THE CAR UP

The jet engine accelerates the car to a speed of about 500 km/h, and subsequently, a hybrid rocket engine burning both solid and liquid fuel takes over.

Manufactured by Norwegian missile specialist Nammo, the hybrid engine was chosen due to the advantages of the two

types of fuel. A solid-state rocket is simple and high-performance, but once it has been ignited, it will keep on burning, causing problems, in case the car needs to stop. A liquid fuel rocket is also high-performance, it can be throttled en-route, but it is also extremely complex, involving a greater risk of errors. The solution is combining 181 kg of solid fuel in the shape of a type of synthetic rubber, HTP, with liquid fuel.

The hybrid rocket is still in the design phase, but the team expects its force to be 123 kN, similar to the jet engine of an F-16 aircraft. The car's total combined power will be 212 kN or 135,000 hp - that's over 100,000 kW.

Attaining the above and a speed of thousands of kilometres per hour is a

challenge, but decelerating, before the car runs out of track, is an equally demanding task. The car is equipped with three separate systems - air brakes, braking parachutes, and wheel brakes. Luckily, air resistance also benefits the car: At the moment when Andy Green lets go of the accelerator, the braking effect will be more than 100 km/h per second. At a speed of 1,300 km/h, the air brakes - two large, perforated pieces of metal plate that function by increasing the air resistance of the car - are activated. At a speed of 1,000 km/h, a braking parachute is released to produce air resistance of about 60 kN. One more parachute can be released, before the wheel brakes are deployed at a speed of 400 km/h. The sudden deceleration from a high speed will trick Andy Green's inner ear and create a so-called "somatogravic" illusion of him driving into Earth's interior instead of continuing forwards.

Once the team has acceleration and braking under control, it is also necessary to make sure that the 7,786 kg car behaves correctly as it passes through the air. This is critical for the car to attain the required speed, but it is also vitally important for safety. If the car design is faulty, the motion of the air around the car will produce lift, which could make the car take off and crash at an extremely high speed.

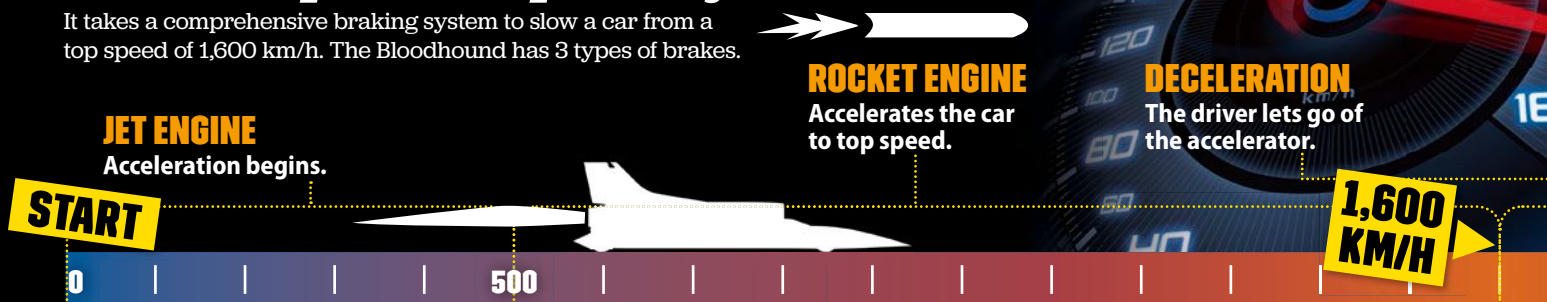
At a speed of 1,600 km/h, 1 km is covered in 2.23 seconds, and any problems will occur much faster than humans can comprehend or react to.

RECORD REQUIRES LONG TRACK

At a speed of 1,600 km/h, the car will cover 10 km in 22 seconds, and the speed the team is targeting means that the Bloodhound record attempt could be one of

Record speed requires four brakes

It takes a comprehensive braking system to slow a car from a top speed of 1,600 km/h. The Bloodhound has 3 types of brakes.



BLOODHOUND SSC BY THE NUMBERS



3,000°C

- the temperature in the rocket combustion chamber. Twice as hot as a volcano.



64,000 litres

per second - the air consumption by the jet engine. Like totally emptying an ordinary suburban home of air in **5 seconds**.

55 SECONDS

- acceleration from 0 to 1,600 km/h.



180 dB

- **full power sound level.**

Permanent hearing damage occurs at 120 dB.

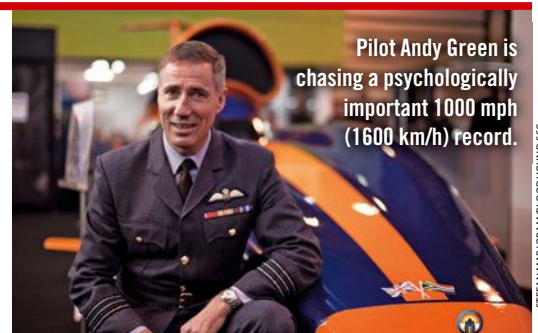
17 seconds

- acceleration time from **800 to 1,600 km/h**, once the rocket has been ignited. The speed increases by 50 km/h per second.

the last of its kind. Not only because it is physically impossible to go any faster, but as it is impossible to find a track that is long enough.

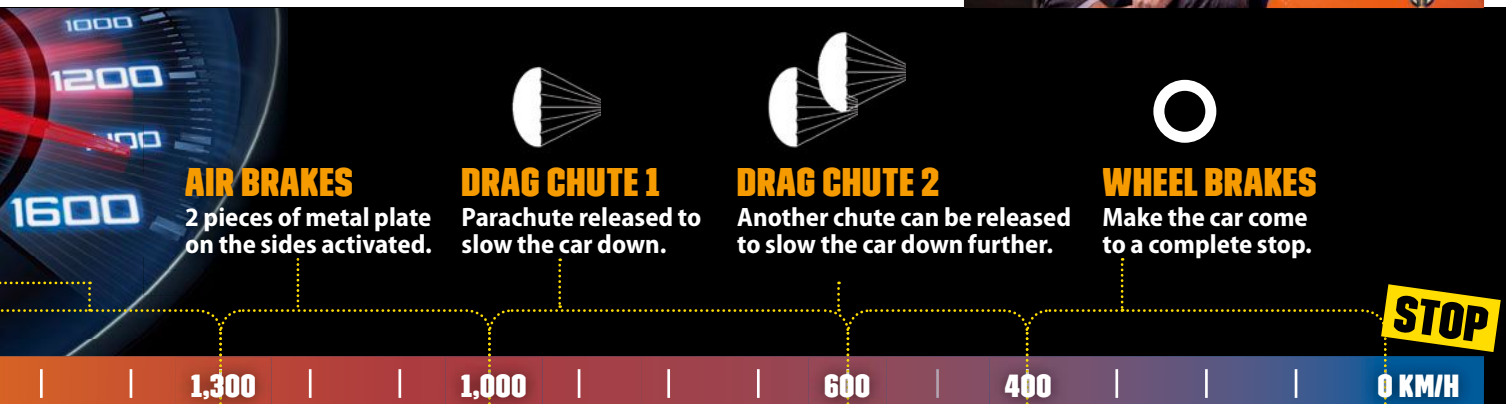
The location of the Bloodhound record attempt will be the dry lake of Hakskeen Pan in South Africa, which has

a unique 19 km of track. In 2015, test runs will seek to reveal any problems there may be, and not until all systems have been thoroughly checked and tested, Andy Green will rev up the engines and set out towards the horizon at a speed of 1,600+ km/h. **SCI**



Pilot Andy Green is chasing a psychologically important 1000 mph (1600 km/h) record.

STEFAN MARU/GRAMMELOUNDS SSC



INHERITING FEAR

Trauma can be passed on for several generations, according to new research. The inheritance is due to so-called epigenetics, which enables the body to store parents' experiences in their offspring. The mechanism will quickly gear the next generation up for survival in new surroundings, but it can also cause anxiety and depression.

LENNART NILSSON/IT

By Gorm Palmgren

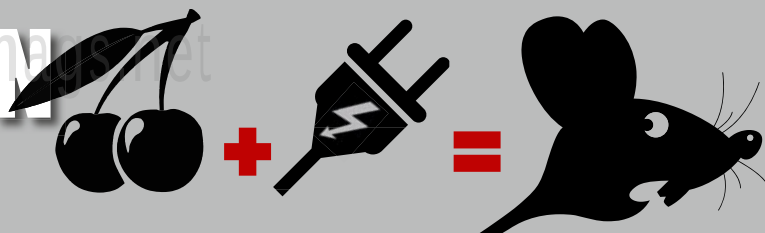
Women who were pregnant during the 9/11 World Trade Centre terror strike and developed post-traumatic stress, passed the risk of developing the disorder on to their children.

MASATOMO KURIYA/CORBIS/ALL OVER

1ST GENERATION

In an experiment, male mice were subjected to a synthetic smell of cherries, as their feet got electric shocks. Soon, the mice jumped at the smell of cherries.

SHUTTERSTOCK



The Holocaust did not only leave its mark on the victims in the shape of a prisoner number tattoo on their arms. The victims' horrific experiences were apparently passed on to their children and grandchildren – in spite of nobody telling them about the pain that their parents experienced in the concentration camp.

However, inherited fear should not exist. According to classical genetics, genes only change due to accidental mutations, not through experience. But new research demonstrates that traumatic experiences such as the Holocaust and the 9/11 terrorist strike in 2001 may affect the genes, so the trauma is passed on.

MICE INHERITED FEAR OF CHERRIES

In early 2014, two scientists, Brian Dias and Kerry Ressler from the Emory University School of Medicine in Atlanta, USA, published the results of an experiment, which showed how unpleasant memories can be inherited.

The scientists subjected young male mice to the smell of cherries as the mice were given electric shocks in their feet. The

unpleasant treatment soon made the mice jump with fear when subjected to the smell of cherries, including when they did not get electric shocks.

The scientists made the timid mice mate with ordinary female mice. At the moment when the new babies were subjected to the smell of cherries, sure enough they jumped with fear.

The offspring had never been subjected to the smell of cherries before, nor to electric shocks in their tiny feet. Nevertheless, they reacted to the parents' learned fear of cherries. In other words, the offspring inherited the fear. The scientists showed that even when the timid males' sperm was used for artificial insemination, the next generation inherited the fear. The fear was hidden in the sperm.

GENETIC MATERIAL MARKED

Inherited fear is probably due to stressed brains producing tiny molecules that flow with the blood and mark the genetic material. Known as epigenetics, the phenomenon allows the environment to change the function of genes fast and without mutations, that is, without changing the genetic code. Epigenetics simply means "on top of genetics" and is a layer on top of the DNA, which can activate and deactivate genes.

So, a traumatic experience can activate and deactivate certain

genes in a parent-to-be, making the body behave differently. The mechanism is usually good. For example, it could come in handy for a plant suffering severe drought. By means of the epigenetic activation ▶

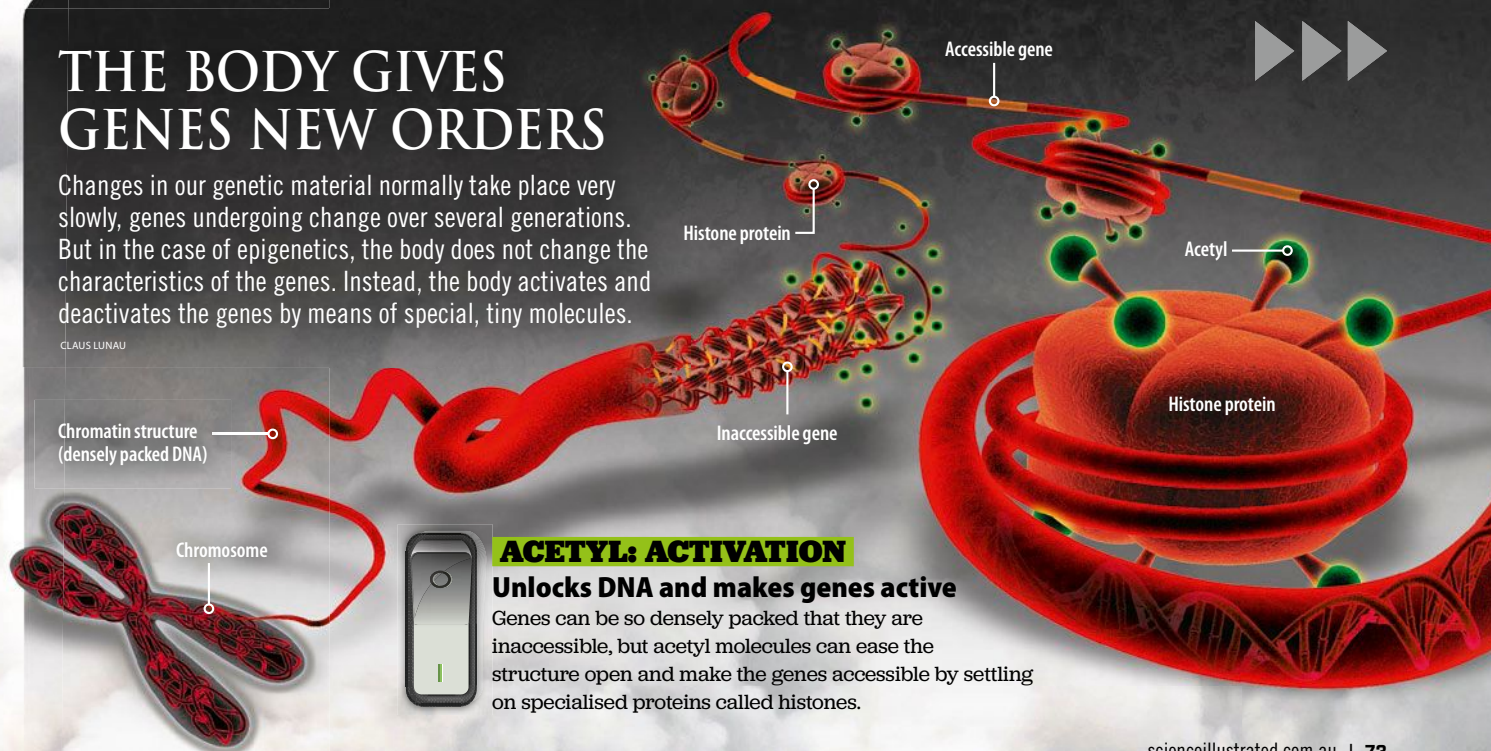
66

Inherited fear should not exist. According to classical genetics, genes only change due to accidental mutations, not through experience

THE BODY GIVES GENES NEW ORDERS

Changes in our genetic material normally take place very slowly, genes undergoing change over several generations. But in the case of epigenetics, the body does not change the characteristics of the genes. Instead, the body activates and deactivates the genes by means of special, tiny molecules.

CLAUS LUNAU



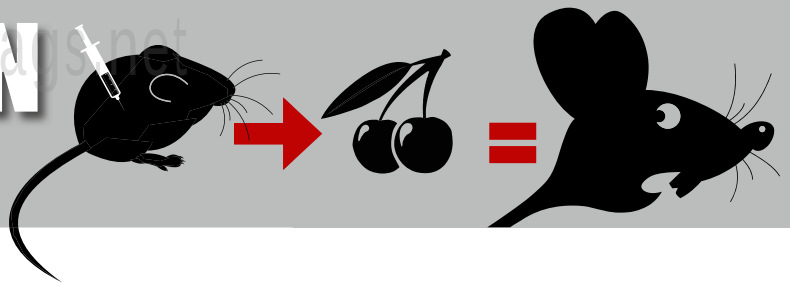
ACETYL: ACTIVATION

Unlocks DNA and makes genes active

Genes can be so densely packed that they are inaccessible, but acetyl molecules can ease the structure open and make the genes accessible by settling on specialised proteins called histones.

2ND GENERATION

Sperm from the traumatised first-generation male mice was used to inseminate female mice without traumas. The offspring inherited the fear of the cherry smell.

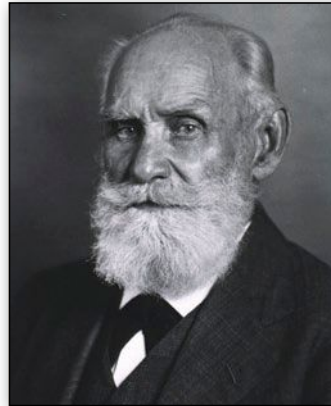


► or deactivation, the plant can quickly re-programme its seeds, making its offspring better equipped for survival on much less water during germination. So, epigenetics allows the next generation a chance to handle new surroundings more efficiently. But epigenetics is also the reason why the consequences of war, terror, disasters, famine, and abuse are not only a problem for the victims, but also for their children and grandchildren.

MENTAL ILLNESS PASSED ON

The fear of the mice is comparable to post-traumatic stress disorder (PTSD), which afflicts war veterans, etc. A major study of war veterans and their sons demonstrated that the sons suffered a considerably higher risk of developing traumas themselves than the sons of non-traumatized fathers.

The same trend can be observed in the descendants of Holocaust victims. In 2008, Rachel Yehuda from the Icahn School of Medicine at Mount Sinai in New York City studied the incidence of mental illness among 211 adult children of Holocaust survivors. According to the study, the



REACTION TO BELL WAS INHERITED

In 1923, Russian scientist Ivan Pavlov tried to teach mice to react to a bell when they were about to be fed. After 300 times, the mice understood the signal, running to the feed bowl. Their offspring learned the lesson after 100 times, the third generation after 30 times, and the fifth generation after just five times. We do not know if the learning was due to epigenetics, but if so, Pavlov was a pioneer in the field.

NLM

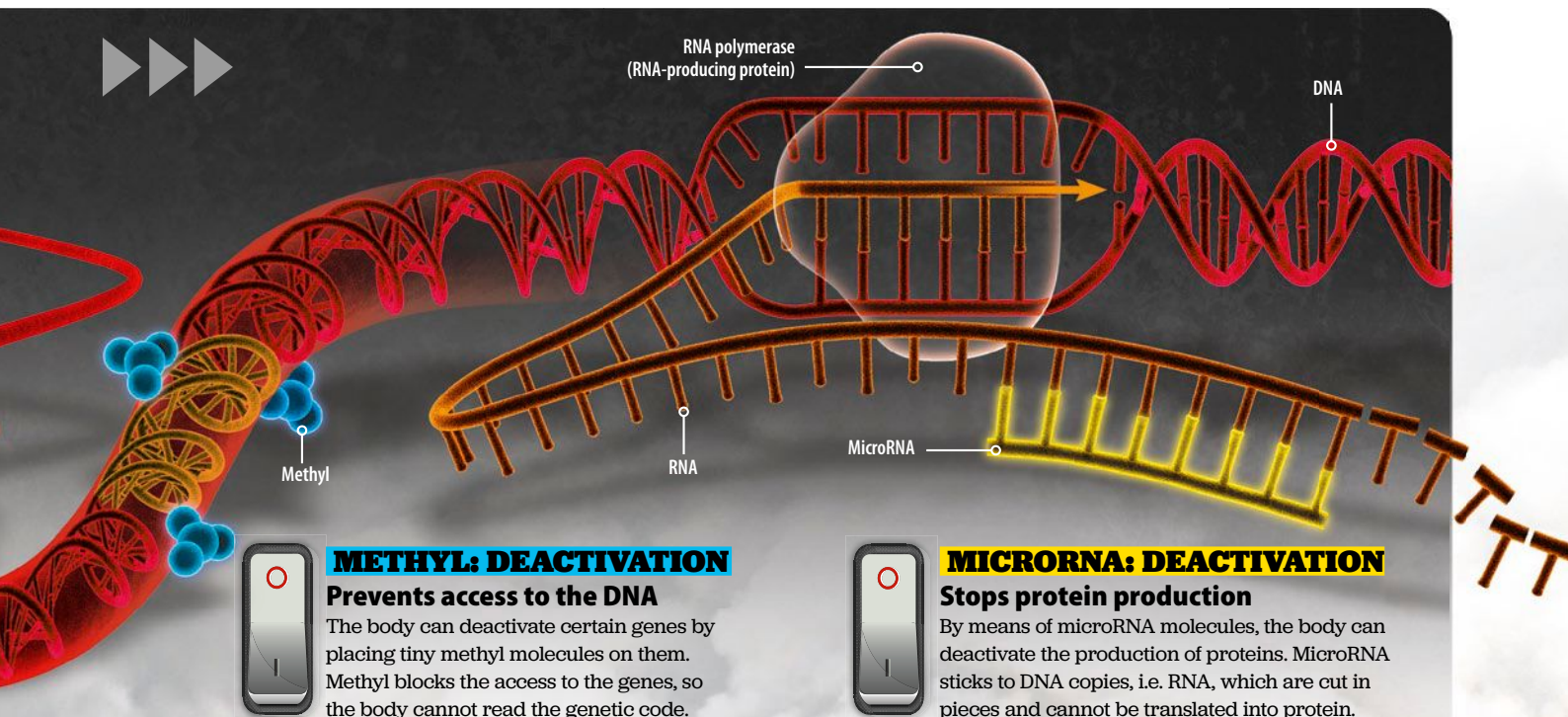
children suffered a 2-4 times bigger risk of developing PTSD, depression, anxiety, eating disorders, or drug abuse than other kids, although the parents never shared their experiences.

Studies indicate that it does indeed matter whether the mother or father had traumatic experiences. Children of concentration camp victims were markedly more likely to develop PTSD and eating disorders, if their mothers had the disorder than if their fathers were ill. On the other

hand, the risk of developing anxiety and adaptation disorders was much bigger, if their fathers suffered from the disorder.

PRE-PROGRAMMED SPERM AND EGGS

In the mouse experiment, the fear was apparently located in the sperm cells. But this is contrary to ordinary genetics, in which characteristics such as eye colour come from both parents and are not bound to neither sperm nor egg. So, Brian Dias and



METHYL: DEACTIVATION

Prevents access to the DNA

The body can deactivate certain genes by placing tiny methyl molecules on them. Methyl blocks the access to the genes, so the body cannot read the genetic code.

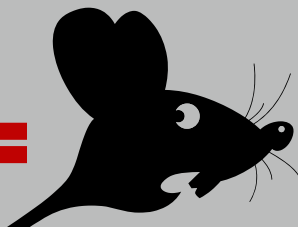
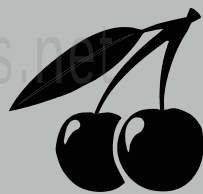
MICRORNA: DEACTIVATION

Stops protein production

By means of microRNA molecules, the body can deactivate the production of proteins. MicroRNA sticks to DNA copies, i.e. RNA, which are cut in pieces and cannot be translated into protein.

3RD GENERATION

In an experiment, traumatised second-generation male mice mated with ordinary female mice, and the offspring became timid. The behaviour had been inherited from the grandfather.



Kerry Ressler took a new look at their cherry-fearing mice to see if the sperm was really marked.

Using sophisticated methods, they searched the chromosomes in the animals' sperm cells for traces of epigenetic marks. The study showed that the *Olf151* gene, which is responsible for the ability to register the smell of cherries, had indeed been epigenetically altered by small methyl molecules. Methyl can be observed as a particular pattern on a gene. The gene is deactivated, because it cannot be read and translated into protein. The tiny methyl molecules made up a particular pattern on the DNA of the sperm cells.

According to the scientists, the traumatic experience caused by repeated electric shocks combined with the smell of cherries altered the pattern of methyl molecules on the *Olf151* gene. Consequently, the smell of cherries was associated with the traumatic experience.

TINY MOLECULES FLOW WITH THE BLOOD

The scientists were puzzled by one thing: the tiny methyl molecules were located in the mice's sperm cells. But smells are registered in the brain, so it remained a mystery how the pattern could move from the brain into male mice's sperm cells. In order for epigenetics to be passed on, the activation/deactivation mechanisms must be moved to the gametes.

Scientist Isabelle Mansuy from the University of Zurich subsequently made a number of experiments revealing the responsible molecules that move between the brain and the testicles. In May 2014, she published the results of a study, in which infant mice were traumatised by their mother being

taken away from them. The neglect particularly had a marked effect on male babies that developed a type of depression. The responsible epigenetic tools were not methyl, but rather short sequences of RNA (a type of DNA copies). Known as microRNA, the tiny RNA sequences regulate the impact of genes. Many different types of microRNA exist, but large quantities of one particular version, miR-375, was present in the traumatised mice - not only in the sperm cells, but also in the brain, where the traumatic experiences are processed, and in the blood, which could take them to the testicles.

9/11 MARKED UNBORN BABIES

According to scientists, microRNA was involved in the inheritance of the childhood neglect. To test the hypothesis, Isabelle Mansuy made an miR-375 solution and injected the molecule into fertilised egg cells from ordinary mice. Already from birth, the babies were depressed and had inherited the trauma.

The 2001 destruction of the World Trade Centre affected pregnant women, who experienced the disaster. Some of the children inherited an increased risk of developing PTSD. The mechanism behind the inheritance has not yet been mapped out thoroughly, but scientists suspect epigenetics, which marked the children with the cortisol stress hormone and made them bad at coping with stress. SCI

Feed which includes epigenetic molecules can make mice slim, although they usually get fat.

RANDY L. JIRTLE



Famine leaves its mark on the victims, so their descendants may develop type 2 diabetes and obesity.

POLFO

HUNGER = FAT KIDS

Several studies indicate that hunger disasters may trigger obesity and type 2 diabetes epidemics. That is so, because famine may spark epigenetic changes, which the children inherit. The changes re-programme both the parents' and the children's metabolisms, so the brain and the body will do anything to avoid death from starvation, gaining as many kg as possible.

YOU WILL BE WHAT YOUR MOTHER EATS

Scientific studies indicate that the mother's diet may affect the baby. In one experiment, scientists used gene-spliced mice with an obesity gene that made the animals fat, ill, and yellow. The yellow mice became pregnant, and some were fed methylic feed. Methyl can deactivate the obesity gene, making the offspring slim, healthy, and brown. The mice that ate methylic feed gave birth to more brown mice than mothers on a normal diet. So, the methyl moved from the mother's feed into the baby. Three generations inherited the genetic mark.

80-YEAR-OLD THEORY PUT TO THE TEST: COLLISION TURNS LIGHT INTO MATTER

Scientists are convinced that light can be turned into matter, but the theory has not been proven, as no device has been able to do the job – until now. A so-called photon collider will help physicists solve one of the biggest mysteries of physics.

By Majken Ellegaard Christensen

After more than 80 years of pondering, physicists have now designed a device which will turn light into matter. Physicists have long dreamed of turning light into matter, as this process took place in the early days of the universe and can provide us with more knowledge about the Big Bang.

In order to turn light into matter, scientists need a device that can produce extremely high-energy light, and for more than 80 years, nobody has been able to invent this light accelerator. The idea for the wild device arose accidentally in the Blackett Laboratory of the Imperial College in London. Physicist Oliver Pike is having a conversation with his colleague, Felix Mackenroth, who is visiting from the German Max Planck Institute for Nuclear Physics. They talk about an instrument by the German name of Hohlraum, which Mackenroth uses in his fusion energy research. Suddenly, Pike realises that the

Hohlraum can be used to prove a 80-year-old theory, according to which light can be turned directly into particles with a mass. That has never been done before.

RELATIVITY THEORY PUT TO THE TEST

Ever since Einstein introduced his relativity theory, physicists have agreed that it must be possible to turn light into matter. With the $E = mc^2$ equation, general relativity implies that energy in the form of light can be turned into matter. In continuation of the theory, physicists Breit and Wheeler in 1934 introduced a theory which says that two high-energy light rays that collide will turn into a positive particle – a positron – and a negative particle – an electron. A positron is the antiparticle of an electron and has the same mass, but a charge of plus one instead of minus one.

But even Breit and Wheeler doubted that the experiment could be realised, as no device was able to supply the weightless light particles with enough energy to produce matter in the collision. And without sufficient energy, the light will simply not collide. Just imagine two laser beams that intersect each other completely undisturbed. But now, the London scientists have designed a device that will probably be able to solve the problem.

Known as a photon collider, the device, that includes the Hohlraum, will turn the photons of light into particles with a mass. In short, light is sent into a box, and what emerges is a flow of electrons.

LIGHT BEAMS COLLIDE

In the experiment, a beam of electrons are fired into a slab of gold. The collision between electrons and gold slab produces a fountain of gamma rays on the other side, which is directed on into a Hohlraum. At the same time, a laser beam is fired into the Hohlraum, and when the laser photons are struck by the gamma rays, the light collides at such energy levels that the photons turn into matter.

Light has been turned into matter in other ways over the years, but never directly. In previous experiments, physicists always used heavy particles as intermediaries. The sensational thing about the London experiment is that the light only collides with itself at the very moment

when it turns into matter.

The next step involves actually making the experiment. Its description is accessible to anyone, so the scientists will probably face competition, as the magic stroke will likely earn a Nobel Prize. Very soon, a physicist could follow in the footsteps of Albert Einstein and Niels Bohr. **sci**

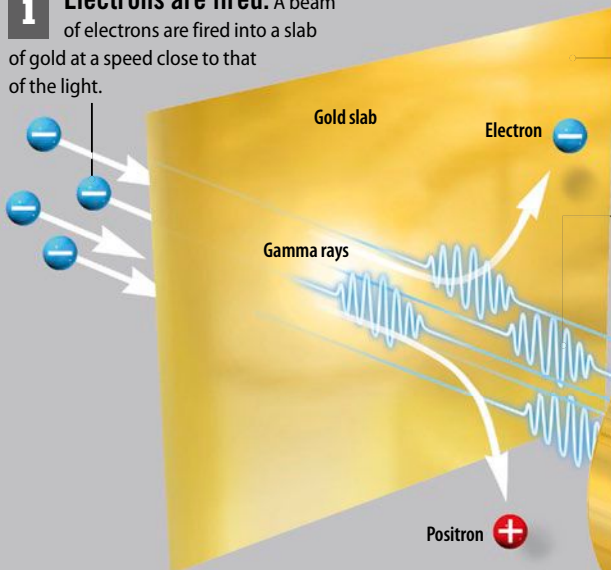
“Two light rays that collide will turn into a positron and a negative particle – an electron”

Right after the Big Bang, the universe was made up of high-energy light. 380,000 years later, the light started to collect into atoms. Physicists now intend to reverse the process by turning light into matter, paving the way for studies of the mysterious cosmic background radiation known as “the Big Bang echo”.

PIXELPARTICLE/THINKSTOCK

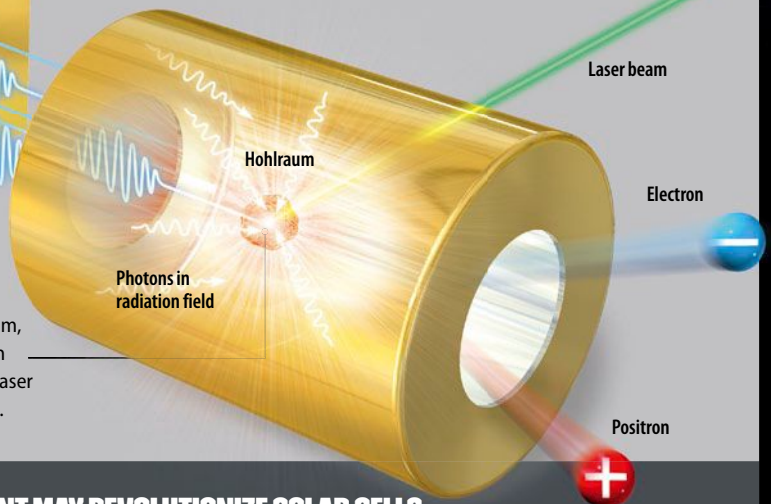
HOW THE COLLIDER WORKS

1 Electrons are fired. A beam of electrons are fired into a slab of gold at a speed close to that of the light.



2 The electrons hit a slab of gold. The tremendous flow of electrons produce gamma rays, electrons, and positrons on the other side of the gold slab. The electrons and positrons are filtered out, and the gamma rays continue straight ahead.

3 Gamma rays are sent into gold container. The oscillation frequency of gamma rays is extremely high, i.e. the rays have a huge quantity of energy per photon. The rays enter a gold container or “Hohlraum”, which is a vacuum and has mirrors on the walls to capture light.



4 Collision produces matter. A laser is fired at the Hohlraum, producing a magnetic radiation field inside the container, which captures photons. The gamma rays collide with the photons from the laser at such a force that an electron and a positron with mass are produced.

HENNING DALHOFF



EXPERIMENT MAY REVOLUTIONIZE SOLAR CELLS

If scientists manage to turn light into particles, the technology may pave the way for a new type of solar cells. Ordinary solar cells capture sunlight in a semiconductor material such as silicon. The

material emits an electron that produces an electric current. In future solar cells, light will probably be converted directly into a flow of electrons without the use of semiconductor materials such as silicon.

1

SPERM WHALE

The champion diver locates prey by emitting loud, clicking sounds.

IMAGESELECT

Uses brain to navigate in the darkness of the deep sea

The sperm whale can dive down to depths of 3,000 m. In the darkness of the deep seas, the whale navigates and locates its prey by means of sonar. So, the champion diver's record big brain is probably a complex navigation instrument. Sperm whale brain studies have shown that the centres for smell and taste are poorly developed. But the auditory centre is very large: the whale has

YOHEI YAMASHITA

highly developed hearing that can process sound impressions very precisely. The part of the brain which controls the limbs in mammals is much diminished, which is not surprising in a whale. But the cerebrum is huge, in absolute terms and compared to the rest of the brain. For a human being, that would mean high IQ, but scientists do not know if it is also true for sperm whales.



2

ELEPHANT



Remembers every waterhole

Reportedly, elephants never forget, and they do indeed have impressive memory. Old animals often become leaders of their groups, as they remember migration routes and the location of waterholes and food sources – knowledge collected during their long lives. Another example of elephants' high IQ is

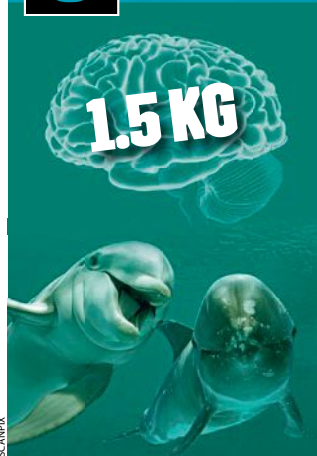
their self-awareness. Unlike many other animals, an elephant can recognise itself in a mirror. Scientists demonstrated this capacity by marking an elephant's forehead with paint and placing it in front of a mirror. Instead of touching the colour in the mirror, the elephant moved its trunk to its own forehead.

Elephants' big brains are memory banks full of data concerning the location of first-rate waterholes and food sources.

Science Illustrated ranks the biggest brains measured in absolute terms, ranked by average weight.

The weight indicated is an average for the species – individuals with both bigger and smaller brains exist. Other animals may have been added to the list, such as some of the big whales, but the weight of their brains is unknown.

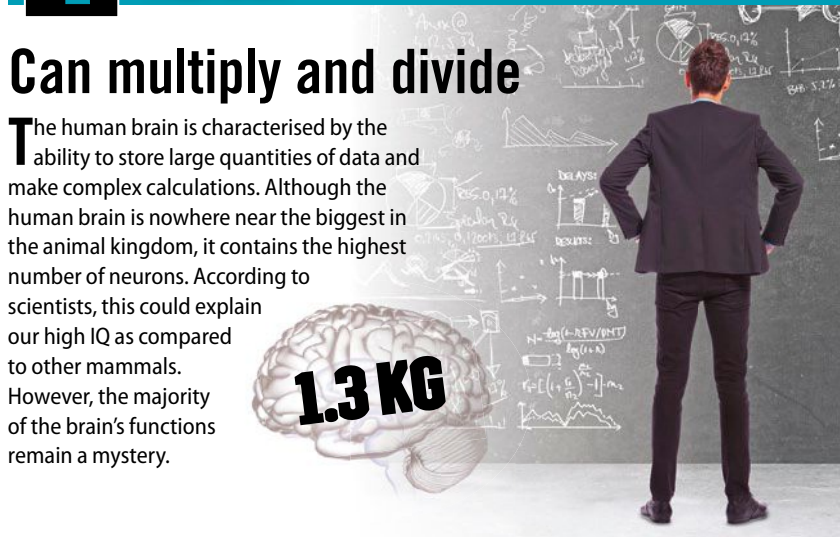
3 BOTTLENOSE DOLPHIN



Names its offspring

Bottlenose dolphins have developed a sophisticated language, by which they name each other. They assign a distinct whistling sound to each of their young, which they use to summon them. Part of bottlenose dolphins' consciousness is used for physiological purposes such as breathing, which humans do automatically. So, bottlenose dolphins must let one cerebral hemisphere sleep at a time. EEG measurements show that the activity falls in one brain half, as the dolphin closes one eye. After 30-60 minutes, the procedure is repeated in the other hemisphere of the brain.

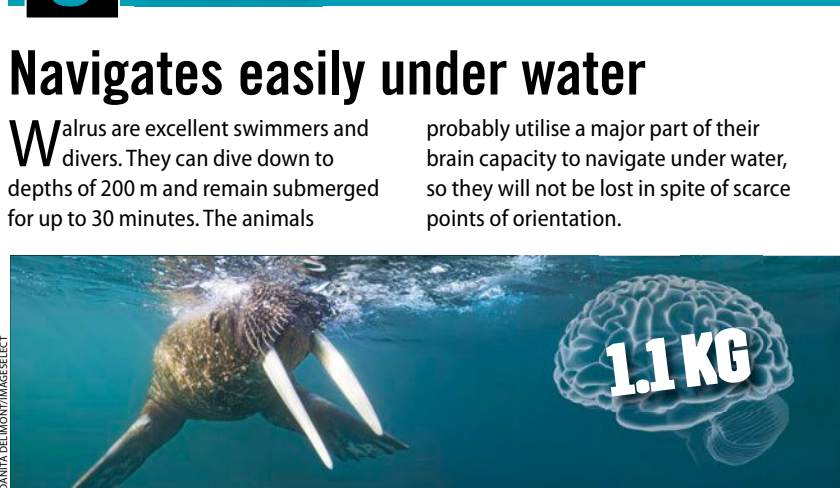
4 HUMAN



Can multiply and divide

The human brain is characterised by the ability to store large quantities of data and make complex calculations. Although the human brain is nowhere near the biggest in the animal kingdom, it contains the highest number of neurons. According to scientists, this could explain our high IQ as compared to other mammals. However, the majority of the brain's functions remain a mystery.

5 WALRUS



Navigates easily under water

Walrus are excellent swimmers and divers. They can dive down to depths of 200 m and remain submerged for up to 30 minutes. The animals

probably utilise a major part of their brain capacity to navigate under water, so they will not be lost in spite of scarce points of orientation.

6 CAMEL

Finds its way through the desert

Camels walk long distances through desert landscapes. Consequently, the animals probably utilise their brain capacity to figure out routes based on minute changes in the landscape.

SHUTTERSTOCK

7 GIRAFFE

Keeps track of the group

Giraffes live in groups, but the members are often scattered to the four winds, so they need to know each other's whereabouts.

SHUTTERSTOCK

8 HIPPO

Small brain compared to the body

Although a hippo weighs a few tonnes, its brain only weighs 585 g. So, hippos live simple lives that do not require much brain activity. They spend their days in water to cool off, and during the night, they move onto the shore to graze.

9 LEOPARD SEAL

Incredibly curious and a fast learner

Leopard seals are difficult to study in the wild, as they live alone, scattered across long distances. But according to trainers working with captive animals, the seals are fast learners and curious.

10 HORSE

Highly trainable

Horses are gregarious animals and generally easier to train than loners, as they are more willing to attach themselves to humans, but it requires some IQ.

SHUTTERSTOCK

TRIVIA

PUT YOUR KNOWLEDGE
TO THE TEST

1. In 1935, entomologist Walter Froggatt was the only prominent scientist to warn against introducing which foreign species to Australia?

2. The commercial spacecraft currently being used to resupply the ISS is named after which mythological creature?

3. The name "coyote" is derived from which ancient American language?

4. Unless its orbit is corrected, which famous scientific instrument will fall to Earth and burn up some time before 2024?

5. Which new word, meaning "to inhale from an e-cigarette" was added to the Oxford Dictionary in 2014?

6. Often caused by increased fluid pressure in the eye, which condition is the second-leading cause of blindness (after cataracts)?



q. 5

7. Recent experiments suggest which common home entertainment technology could be recycled and used to make solar panels?

8. Excessive consumption of which traditional Christmas meat could increase your risk of getting pancreatic cancer?

9. Synthetic silicon carbide, harder than sapphire or ruby, is a new competitor for which popular gemstone?

10. Which new American car brand, famous for electric vehicles, is now selling its cars in Australia?

ANSWERS ON p82!

Trivia Countdown (use fewer clues, get a higher score!)

	5 POINTS	4 POINTS	3 POINTS	2 POINTS	1 POINT
1. MEDICINE Name this type of surgery	Some 3,500 procedures of this kind are carried out annually at the Cedars-Sinai Medical Centre in the US.	The surgery took place for the very first time in Cape Town, South Africa, on 3 December 1967.	Former US Vice President Dick Cheney had the operation in March 2012.	It is a transplant. Most organs come from deceased people, but scientists are working on artificial versions.	The organ which is transplanted into the body is called cor hominis in Latin.
2. TECHNOLOGY Name this structure	Copies are found in many places throughout the world, such as in Shenzhen and Hangzhou, China.	The structure was the portal of entry of a world fair, and it was finished in 1889.	Between 1889 and 1930, when it was outcompeted by the Chrysler Building, it was the world's tallest.	The structure is a tower resting on four legs and overlooking a major river.	The tower is located in Paris and has become a world-famous symbol of the city.
3. COLOURS Name this colour	Light of this colour has an approximate wavelength of 620-640 nanometres.	Giant stars such as Antares and Betelgeuse often have this colour.	When the Spanish arrived in Mexico, they were introduced to the cochineal scale insect and its dye of this colour.	The Russian name of the colour, krasnyj, also means beautiful. The word is known from a big Moscow square.	The colour is often associated with danger, blood, and socialism – and in China with happiness.

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Red Beard Orchid
(*Calochilus paludosus*)

INSECT-MIMICKING ORCHIDS

Calochilus sp. / *Caleana* sp. / *Cryptostylis* sp.

- Rely on insects for pollination
- Do not provide nectar
- Tiny plants easy to miss
- Look exotic, but often common

OPERATIC ORIGINS

The Flying Duck orchid, despite its crazy Amazonian appearance, is actually a fairly common little plant - though when it's not flowering, you'd be forgiven for overlooking it. It was first scientifically described back in 1803, at Bennelong Point in Sydney... the current site of the Opera House.

Flying Duck Orchid
(*Caleana major*)

PHOTOGRAPHY BY DAMON WILDER

SEDUCE BUGS, GET POLLINATED

Most flowering plants have a deal with insects: the plant grows a bright, eye- or nose-catching flower full of nectar, the insect comes for a free feed, and pollen rubs off one plant and, hopefully, onto another. It's actually amazing how much human agriculture relies on this 150-million-year-old arrangement between plants and bugs - it's a big part of why we're so concerned about any threats to commercial beehives, for instance. Fruit growers in particular rely on insect pollination for their crops.

Yet some plants are a little more one-sided about using insects for pollination. These insect-mimicking orchids, for instance. Rather than provide a tasty meal of nectar, they instead grow amazing flowers that look like female bugs. A male

comes along expecting sexy times, gets covered in pollen, and then flies off to try again on another orchid.

It may seem a little unfair, but occasionally the system doesn't work out so well for the plants. Without a tasty meal on offer, the orchid can't compete when the bugs have a bumper hatching season with lots of females. If every male bug can find a real female easily, the orchids miss out.

To maximise their chances, the shapes and forms of these orchids are incredibly complex. The Large Tongue Orchid (*Cryptostylis subulata*) is so good at fooling a particular species of ichneumon wasp (*Lissopimpla excelsa*), we call it the "orchid dupe wasp". And the Flying Duck Orchid (*Caleana major*) really does look like a little duck taking off, right down to the legs curled up alongside the body. When an



Large Tongue Orchid
(*Cryptostylis subulata*)

insect lands on it, the weight of the bug closes the flower up in such a way that the only exit is via a generous smear of pollen.

The Red Beard Orchid (*Calochilus paludosus*) is less common, but you can find it tucked away in swampy heathland and up on mountain ridges. As with all these amazing plants, you need to keep your eyes peeled - each is only 10-20 cm tall and blends in with dozens of other plants.

So what of those sexually frustrated wasps, sawflies and beetles? Before you feel too bad for them maybe we should ask: do they even KNOW they got it wrong? **SCI**

NEW-TECH'15

JULY 31-AUG 2 | SYDNEY SHOWGROUND

EXPERIENCE LIFE-ENHANCING TECHNOLOGY
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FOR EVERYONE
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